SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RELATION OF FORESTS IN THE ATLANTIC PLAIN TO THE HUMIDITY OF THE CENTRAL STATES AND PRAIRIE REGION

INTRODUCTION

MANY of the dreams or presentiments of the early scientists are now coming true every day. The dreams of the alchemists are now almost within the realization of modern chemistry. The gropings of the early biologists are almost within reach of present-day experimental embryology, and so on practically in every science; at first a presentiment, "a hunch," which can not be substantiated by any scientific facts. This, later, with the accumulation of more accurate observations is often entirely denied or minimized, only to reappear again, not as a presentiment any more, but as a scientifically established fact.

From the earliest times there existed among laymen, and even scientists, a belief that forests exercised an influence upon the climate of entire countries. With the introduction of accurate methods of meteorological observations, this popular conception has seemingly been greatly discredited. All that most of the meteorologists were willing to admit was that forests have a local influence upon climate, extending only over the territory actually occupied by them. Within recent years, just when this view seemed to be completely disposed of, many new facts came up independently in different countries, which point strongly to the possibility of the forest exerting a potent influence upon the humidity of regions lying far away from it. I shall attempt to consider in the light of these new facts the conditions prevailing in the eastern part of the United States, and to es-

tablish a relation between the forests of the coastal plain and the southern Appalachians, on the one hand, and the humidity of the central states and prairie region, on the other.

There are three fundamental facts upon which, in my judgment, this relation is based.

1. In the eastern half of the United States there is a marked periodicity in the wind direction. In winter the prevailing winds are from the north and northwest; in summer the prevailing winds are from the south. When the prevailing winds come from the south the entire eastern half of the United States is wet. When the prevailing winds are from the northwest and west the precipitation decreases. Therefore, the precipitation of the eastern half of the United States depends largely upon the prevailing southerly winds which come from the Gulf and penetrate far into the interior of the continent.

2. The evaporation from the ocean plays a comparatively unimportant part in the precipitation over the land; *seven ninths* of the precipitation over land is supplied by evaporation over the land itself and only two ninths is furnished by the evaporation from the ocean. Therefore, the greater the evaporation from the land which is in the path of the prevailing southerly winds, the more moisture must be carried by them into the interior of the continent.

3. The forest evaporates more water than any vegetative cover and much more than free water surfaces. Therefore, forests enrich with moisture the winds that pass over them and contribute to the humidity of the regions into which the prevailing air currents pass.

PERIODICITY OF WIND DIRECTION IN THE EASTERN HALF OF THE UNITED STATES

After Asia, North America is the largest continent in the world. One of the most striking physiographical features of North America is that the mountains run along the meridians and not along parallels. The entire northern part of the American continent has no high mountains except in the western part. As the result of this the central part of the continent does not offer any obstruction to winds from the 30th to 70th degree of northern latitude, that is, from the Gulf of Mexico to the Arctic Sea. Even the Asiatic continent does not have such a large continuous area free of mountains extending along the meridian. There the greatest extension is from the 38th to the 73d degree of northern latitude, that is, from the southern border of the plain of Touran to the northern shores of western Siberia. To the south of the 30th degree extend the waters of the Gulf of Mexico. The mountains on the southern shore of the gulf begin only at 19 degrees of north latitude. The North American continent, therefore, together with the interior lakes forms an expanse for the movement of the air between the tropical and Arctic regions, such as is found outside of it only on large oceans, in the northern hemisphere, on the Atlantic Ocean.

Another climatic peculiarity of the eastern United States which has a bearing upon the question under discussion is the rapid decrease in temperature from south to north. Take, for instance, Labrador; it is entirely an Arctic region where agriculture is impossible. Yet it lies in latitudes at which in Europe and Asia agriculture is still flourishing and large populous cities are found (in 53d to 60th degree northern latitude are found Christiania, St. Petersburg). Florida, on the other hand, between 25th and 30th degree of north latitude, is almost a tropical country. Between Florida and Labrador the drop of temperature for each degree of latitude (60 miles) is for January 2.9° F., for July 1.08° F. and for the entire year 1.7° F.

Comparing the same latitudes in Europe the drop for each degree of latitude is less than half of that for the North American continent. Between the Canary Islands and northern Scotland the decrease in the mean annual temperature for one degree of latitude is only 0.8 of a degree.

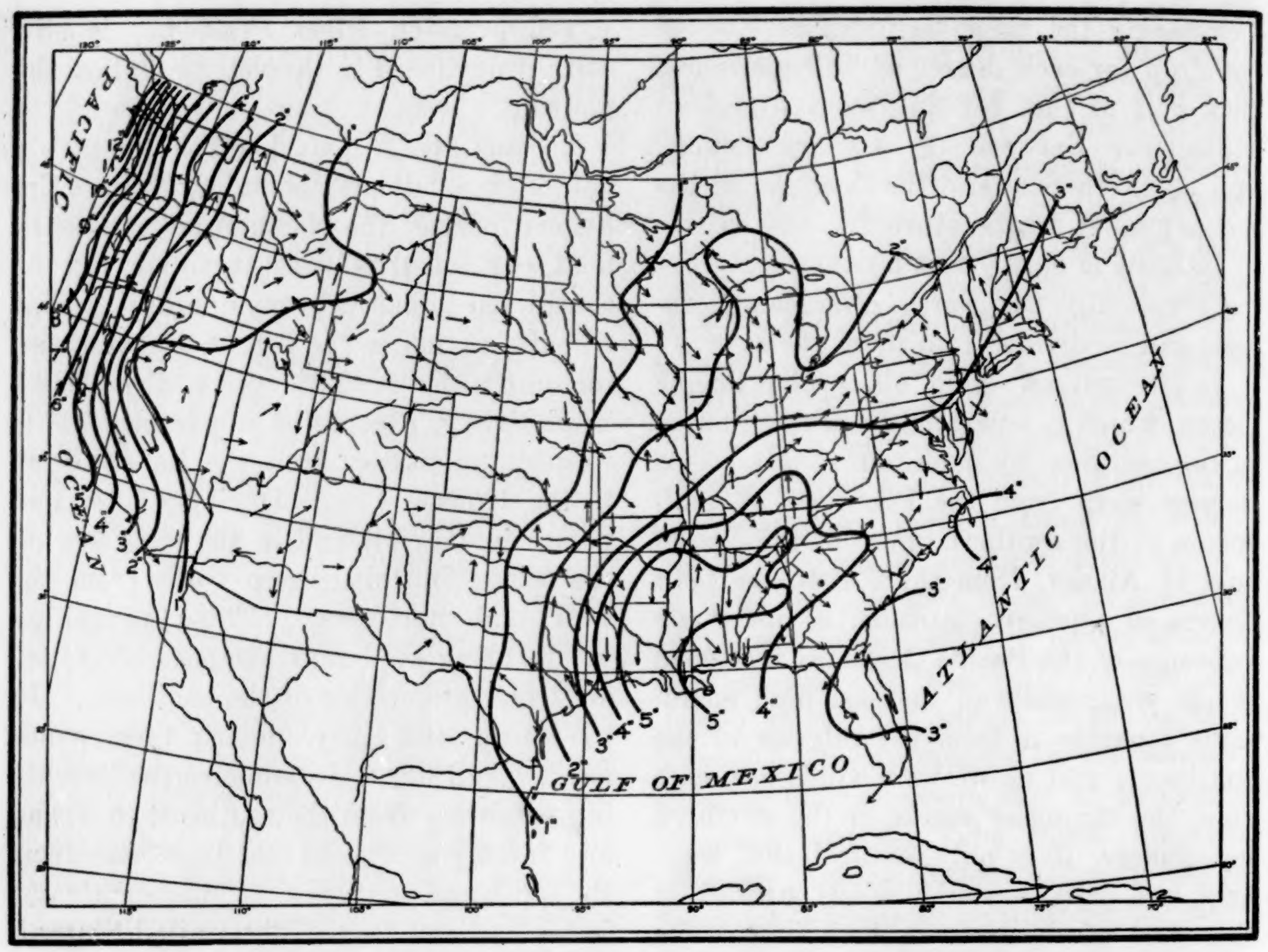
Climatically the North American continent can be divided into three parts:

1. The narrow strip along the Pacific Ocean, which is separated from the interior of the continent by mountain ranges. This narrow strip from the Peninsula of California to the southern shore of the Peninsula of Alaska, from the 32d to the 60th degree of northern latitude, is under the influence of the Pacific Ocean, as it is open to the west, while in the east high mountains separate it from the interior of the continent; and as western winds are, as a rule, the strongest winds in the northern hemisphere, it is only natural that westerly and northwesterly winds prevail in this part of the country both in summer and winter.

2. The region of mountains and plateaus to the east of the Cascades and Sierra Nevada ranges. This extends not only to the Rocky Mountains, but beyond the Rocky Mountains to the 100th meridian. The high plateaus and the low valleys of this region are characterized by extreme dryness and only in the mountains does the snow and rain fall in any abundance. The dryness is due to the fact that the prevailing westerly winds give off the moisture on the western slopes of the Sierra Nevada and Cascades, and become dry winds on the leeward side of these mountains. During the winter the prevailing winds are from the west and northwest, but in the summer the direction of the wind changes considerably, becoming southwesterly. This change in the direction of the wind in summer has been observed even on Pikes Peak, but is still more pronounced in the valleys and on the plateaus.

3. Since the Appalachian Mountains do not offer a climatic boundary, the entire eastern part of the North American continent east of the 100th meridian can be considered climatically as one unit. This climatic region is the largest of the three, including the Atlantic plain, the Mississippi Valley, except the upper part of its western tributaries, and the Lake Region to the Hudson Bay. During winter and partly in the fall and in the early spring the winds in this region come from the west and northwest. These prevailing winds bring cold and comparatively dry air from the interior of the continent. In the spring and early summer these winds are hot and dry. In summer the prevailing winds are from the southeast in Texas, and farther north and east they come from the south and southwest. Professor Henry, in his "Climatology of the United States," says that in midwinter northwesterly winds prevail uniformly over the Missouri Valley and the upper and middle portions of the Mississippi Valley. As the spring advances the region of southeast to south winds spreads northward and eastward from the Texas coast, so that by April it embraces the states of Texas, Oklahoma, Arkansas, Mississippi, Louisiana, Alabama, western Tennessee, Missouri, Kansas, southeastern Nebraska and Iowa. By June the northwest winds of midwinter have been supplanted by southerly winds over practically the whole of the country east of the Rocky Mountains. In autumn the northwest winds become more frequent and as autumn shades into winter they gain the ascendency in the Missouri and Mississippi valleys and the plains states.

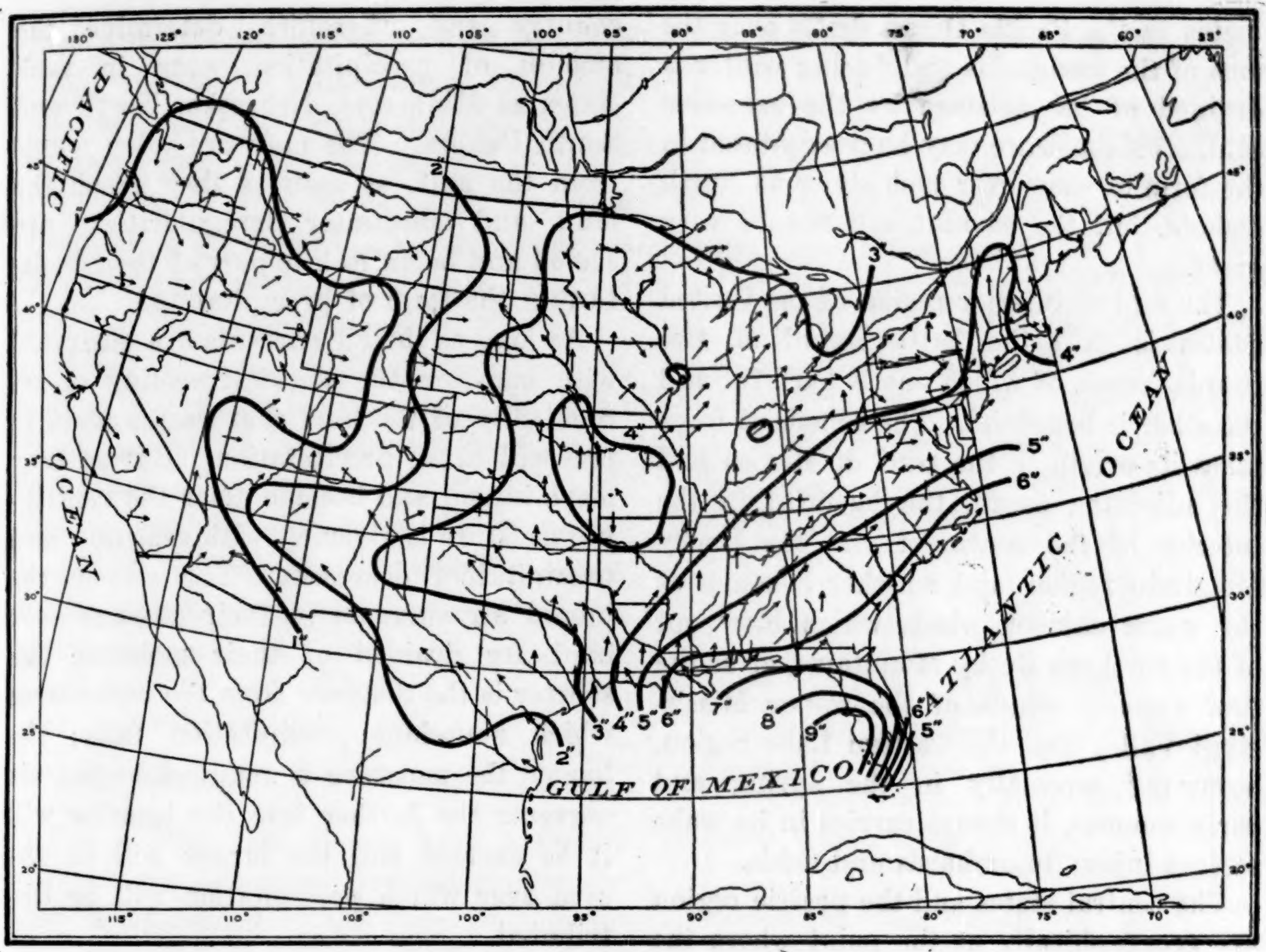
The periodicity is well illustrated on the two maps, on which is indicated by arrows



PREVAILING DIRECTIONS OF THE SURFACE WINDS AND THE MEAN PRECIPITATION IN THE UNITED STATES DURING JANUARY

the direction of the prevailing winds, based on twenty years of continuous records, and by lines the mean precipitation for the months of July and January. The map for the month of July is typical for the summer period and the one for the month of January is typical for the winter period. These maps show, very clearly, it seems to me, that the eastern half of the United States is under the influence of two prevailing winds; one, which originates in the Gulf of Mexico and in the Atlantic Ocean, is mild and humid; the other, which comes from the interior of the continent and from the Rocky Mountain region, is dry and continental in character, that is, dry and cold in winter and dry and hot in the spring and summer.

Another important fact which the records of precipitation and wind direction establish is that there is a most intimate relation between the prevailing southerly winds and precipitation in the eastern half of the United States. It is during the summer period when the entire eastern half of the United States is under the influence of the southerly winds, that most of the precipitation falls over it. On the plains east of the Rocky Mountains the summer rainfall forms from three fourths to four fifths of that of the entire year. In July when the southerly, southwesterly and southeasterly winds extend far into the interior of the continent as far north as North Dakota, and as far west as the foothills of the Rocky Mountains and



PREVAILING DIRECTIONS OF THE SURFACE WINDS AND THE MEAN PRECIPITATION IN THE UNITED STATES DURING JULY

even into eastern New Mexico, and as far east as New England, the precipitation over the entire eastern half of the United States is very heavy. In winter the picture of both wind direction and precipitation is radically changed. The northerly and northwesterly winds have not the same pronounced persistence as the summer winds. Yet through the entire south—Texas, Louisiana and Mississippi—as well as the Atlantic states, the lake states and the central states, the prevailing winds are northerly and northwesterly winds. At the same time there is a perceptible decrease in precipitation through the entire eastern half of the United States, and where in July there fell as much as three inches of rain, in January there is less than one inch, and where in July there fell as much as five inches there is in January less than two inches.

This increase and decrease in precipitation over the eastern half of the United States, with change in the direction of the wind, points to the fact that the eastern half of the United States depends for its moisture upon the prevailing southerly winds, which originate in the Gulf of Mexico and the Atlantic Ocean.

Professor Willis Moore, therefore, is entirely right, it seems to me, when he claims that the Pacific Ocean has little influence upon the precipitation of the eastern half of the United States, as Mr. Gannett and Mr. Bailey Willis have tried to prove. It is possible that some of the vapor that orig-

inates in the Pacific Ocean drifts over the tops of the mountains and during winter is drained of its moisture by the excessive cold. This moisure may be precipitated in the form of snow over such states as North Dakota, but the amount can not be very great.

The central interior region of the United States is thus the battleground of two titanic forces, of which one is harmful and the other is beneficial. The beneficial force takes its origin in the Gulf of Mexico and the adjoining ocean, the harmful in the interior of the continent and the Rocky Mountain region, and whether it comes as the warm chinook winds which blow out of the northern Rocky Mountains, or as the dry westerly winds of the upper Mississippi Valley and the western Lake region, occurring especially in the spring and early summer, it always carries in its wake serious injury to orchards and fields.

The central states and the prairie region are geographically at the point where the battle between the two forces is fiercest and the victory is now on the one side and now on the other, being dependent upon the cold and humid, and the warm and dry, climatic cycles as well as upon the seasons of the year.

When the humid southerly winds extend their influence far into the interior of the continent, and overpower the dry continental winds, the central states and prairie region, the granary of the United States, produce large crops. When the dry winds overpower the humid southerly winds there are droughts and crop failures.

The southerly winds on their way from the Gulf of Mexico do not meet any mechanical obstructions. Since the Appalachian Mountains, running in a northeasterly and southwesterly direction, do not hamper their passage, they are capable of penetrating far into the interior of the country and, therefore, determine the amount of precipitation, even in such states as Minnesota, Nebraska, North and South Dakota. The moisture-laden winds from the gulf, as soon as they reach the land and encounter irregularities, are cooled and begin to lose part of their moisture in the form of precipitation.

As long as the air currents are saturated with moisture the slightest cooling or irregularity of the land that causes them to rise will cause precipitation. But as they move inland and become drier the remaining moisture is given off with difficulty and precipitation decreases. The sooner the humid air currents in their passage over land are drained of their moisture the shorter is the distance from the ocean over which abundant precipitation falls; the longer the moisture is retained in the air currents the farther into the interior will it be carried and the larger will be the area over which precipitation will be distributed.

If precipitation over land depended only on the amount of water directly brought by the prevailing humid winds from the ocean, the land would be pretty arid and rainfall would be confined to only a narrow belt close to the ocean. Fortunately, not all the water that is precipitated is lost from the air currents; a part runs off into the rivers or percolates into the ground, but a large part of it is again evaporated into the atmosphere. The moisture-laden currents, therefore, upon entering land at first lose the moisture which they obtained directly from the ocean, but in their farther movement into the interior they absorb the evaporation from the land. Hence the farther from the ocean the greater is the part of the air moisture contributed by evaporation from the land. At a certain distance from the ocean practically all of the moisture of the air must consist of the

moisture obtained by evaporation from the land. At least it must form a larger part than the water which was obtained directly by evaporation from the oceans.

The vapor brought by the prevailing winds from the ocean is many times turned over or reinvested before it is returned again to the ocean through the rivers.

If we could reduce the surface run-off, and at its expense increase the evaporation from the land, we should thereby increase the moisture of the passing air currents, and in this way contribute to the precipitation of that region into which the prevailing winds blow. This conclusion is almost axiomatic, and there can be no dispute about it.

"CONTINENTAL" AND "OCEAN" VAPOR

For a long time it has been accepted without any question that all the vapor that is condensed in the form of rain or snow over the land surface is furnished by the evaporation of water from the oceans.

The part which vapor from the ocean plays in the precipitation over land has been altogether exaggerated, and it is hardly possible, therefore, to agree with Professor Moore when he says that "the precipitation over the eastern part of the United States is derived entirely from the evaporation from the Gulf of Mexico and the Atlantic Ocean."

A noted European meteorologist, Professor Bruckner, author of a classical work on the climatic fluctuations, has computed the amount of water evaporated from the ocean surface, land surface and the amount of water which is returned to the oceans and the land in the form of precipitation. The balance sheet of the circulation of water on the earth's surface is made up as follows:

CIRCULATION OF WATER ON THE EARTH'S SURFACE
BALANCE SHEET

	Cu. Miles Vapor	Depth Inches	Per Cent.
A. Entire earth surface (196,911,000 miles).			
Evaporation from water surfaces	92,121	29.5	80
Evaporation from land surfaces	+ 23,270	7.5	20
Precipitation on entire earth surface	115,391	37.0	100
B. Oceans (141,312,600 sq. miles).			
Evaporation from oceans	92,121	41.3	100
Amount of ocean vapor carried to the land (net[2])	+ 5,997	2.8	7
	86,124	38.5	93
C. Peripheral land area (44,015,400 sq. miles).			
Ocean vapor (net)	5,997	8.7	29
Continental vapor from the peripheral land surface	— 20,871	29.9	100
Precipitation over the peripheral land area	26,868	38.6	129
D. Closed interior basins with no drainage to the ocean (11,583,000 miles).			
Evaporation from closed basins	2,399	13.0	100
Precipitation over closed basins	2,399	13.0	100

The continental vapor which is fed from the periphery of the land surface is thus about 21,000 cubic miles. It plays, therefore, an important part in supplying the moisture to the air, even a more important part than the vapor directly fed from the ocean. The peripheral regions of the continents, *i. e.*, the regions tributary to oceans, are capable of supplying *seven ninths* of their precipitation by evaporation from their own areas. The moisture which is carried by the winds into the interior of vast continents, thousands of miles from the ocean, is almost exclusively due to continental vapors and not to evaporation from the ocean.

[2] *I. e.*, the difference between the amount of vapor that escapes from land to the ocean and from the ocean to land.

In the interior enclosed basins the precipitation and evaporation, as a rule, are equal to each other.

Bruckner's figures for entire earth's surface are corroborated also by studies of specific drainage areas. The most interesting study in this connection is that by Professors Francis E. Nipher[3] and George A. Lindsay on the rainfall of the state of Missouri and the discharge of the Mississippi River at St. Louis and Carrollton, Louisiana. Nipher found that the average discharge of the Mississippi River at St. Louis during the ten years ending December 31, 1887, was 190,800 cubic feet per second. The amount of water falling per second upon the whole state during the same interval was 195,800 cubic feet per second, or equal within two per cent. to the discharge of the Mississippi River at St. Louis. If, however, a comparison is made between the total rainfall on the basin draining past St. Louis and the river discharge at this point, it appears that the drainage area of the Mississippi and Missouri Rivers above St. Louis is 733,120 square miles, or over 10 times the area of Missouri. These figures show what small portion of the total rainfall over the drainage basin of the Mississippi River is led into the rivers and conducted back to the sea. It is evident that by far the larger portion of the precipitation that falls over the drainage basin is evaporated back from the land into the atmosphere, and is not returned to the sea through the medium of drainage. These figures show further that the source of precipitation of the Mississippi drainage is from evaporation over the land and not derived from evaporation over the sea. Mr. Lindsay[4] computed the discharge of the Mississippi River at Carrollton, Louisiana, and found that the average for fourteen years was 117 cubic miles per year, or 545,800 cubic feet per second, which is less than three times the precipitation over the state of Missouri.

The central portion of the United States is distinctly a continental region, particularly the prairie region, which suffers from lack of precipitation. On the other hand, large areas in the south and southeast suffer from too much humidity because of large swamps, which is caused not only by excessive precipitation, but also by deficient evaporation. Not only the south and southeastern areas suffer from too much water, but also many portions in the north and northeast, where the evaporation is also very slight. We have, therefore, two extremes on the periphery of the United States: (1) In the states adjoining the Atlantic Ocean and the Gulf of Mexico there is an excess of moisture on the ground, both on account of excessive precipitation and slight evaporation; (2) in the vast interior of the central United States, on the other hand, there is a deficiency of moisture, both on account of the scant precipitation and of the intense evaporation. Is there not some connection between these two extremes? Is it not possible that changes which take place in one part of this vast region may exert some influence on the condition of the other? We have seen that in the central states in summer the prevailing westerly and northwesterly winds give way to southerly and southeasterly winds. In other words, in the summer the central states are under the influence of moist

[3] Francis E. Nipher, "Report on Missouri Rainfall, with Averages for Ten Years ending December, 1887," *Transactions of the Academy of Science of St. Louis*, Vol. V., p. 383.

[4] Geo. A. Lindsay, "The Annual Rainfall and Temperature of the United States," *Transactions of the Academy of Science of St. Louis*, June, 1912.

winds, just at the time when the evaporation is the greatest and the forest vegetation is especially active. It seems, therefore, that the amount of moisture evaporated within the more moist region of the United States can influence the conditions of humidity, not only in the States close to the ocean, but also in the region into which the prevailing moist winds flow. The more moisture there is evaporated from the ground in the southern and southeastern portions of the United States, the moister must be the air in the central states and the more precipitation must fall there.

FOREST THE GREATEST EVAPORATOR OF WATER

What are the sources from which the evaporation on land is the greatest? The evaporation from a moist, bare soil is, on the whole, greater than from a water surface, especially during the warm season of the year when the surface of the soil is heated. A soil with a living vegetative cover loses moisture, both through direct evaporation and absorption by its vegetation, much faster than bare, moist soil and still more than free water surface.

The more developed the vegetative cover the faster is moisture extracted from the soil and given off into the air. The forest in this respect is the greatest desiccator of water in the ground.

The latest experiments of Russian agronomists and foresters, corroborated by similar observations in France and Germany, have proved that in level or slightly hilly regions the forest has a desiccating effect upon the ground, causing the water table to be lower under forest than in the adjoining open fields. Professor Henry, in his recent investigations on the effect of forests upon ground waters in level country, has found that the minimum depression of the water table produced by the transpiration of forest trees in the Mondon forest near Luneville, France, amounts to 11.8 inches. With a porosity of the soil strata ranging between 45 and 55 per cent., such depression would correspond to a rainfall of 5.9 inches, which amount to 21,443 cubic feet per acre. This amount of water given off by the forest into the air obviously contributes greatly to the moisture content of the atmosphere above the forest. Dr. Franz R. von Höhnel, of the Austrian forest experiment station at Mariabrunn, carried on observations for a period of three years (1878–1880) upon the amount of water transpired by forests. He found that one acre of oak forest, 115 years old, absorbed in one day from 2,227 to 2,672 gallons of water per acre, which corresponds to a rainfall of from 0.09 to 0.115 inch per day, or 2.9 to 3.9 inches per month. Taking the period of vegetation as five months, the absorption of water would be 158,895 cubic feet, which represents a rainfall for this period of 17.7 inches. This amount of water is given off merely through transpiration from the leaves and does not include the physical evaporation from the surface of twigs, branches, and leaves. These figures, while only approximate, give an idea of the enormous quantities of water given off by forests into the air, which has justly given them the name of the "oceans of the continent."

The most valuable and complete work on the subject is by Otozky, a Russian geologist and soil physicist, which appeared as a publication of the forest experiment stations. Otozky worked up an enormous amount of observations, both his personal and those furnished him by other people, and did not find a single contradictory fact. His conclusion is that the forest, on account of its excessive transpiration, consumes more moisture, all other conditions

being equal, than a similar area bare of vegetation or covered with some herbaceous vegetation. The amount of water consumed by forests is nearly equal to the total annual precipitation; in cold and humid regions it is somewhat below this amount and in warmer and dry regions it is above it.

This enormous amount of moisture given off into the air by the forest, which may be compared to clouds of exhaust steam thrown into the atmosphere, must play an important part in the economy of nature.

If the present area occupied by forests in the Atlantic plain and the Appalachian region were instead occupied by a large body of water, no meteorologist would hesitate for a moment to admit that the water surface has a perceptible influence upon the humidity of the central states and prairie region. Should not, therefore, forests which give off into the atmosphere much larger quantities of moisture than free water surface, have at least a similar influence upon the regions into which the prevailing air currents flow.

If the southern and southeastern winds, in their passage toward the north, northwest and northeast, in the spring and summer, did not encounter the vast forest areas bordering the shores of the Gulf of Mexico and the Atlantic coast and those of the southern Appalachian, and, therefore, were not enriched with enormous quantities of moisture given off by them, the precipitation in the central states and the prairie region would undoubtedly be much smaller than it is now.

What would be the effect of complete or even partial destruction of forests in the Atlantic plain and in the southern Appalachian Mountains upon the humidity of the continental portion of the United States? As the mean temperature in the eastern part of the United States drops rapidly from south to north, the moisture-laden air currents upon entering land would be cooled off and rapidly drained of their moisture within a comparatively short distance from the ocean. The sandy soil which is so characteristic of the southern pine belt of the gulf and south Atlantic States would rapidly absorb the rain which would percolate into the ground, without returning much of it into the atmosphere. The rain falling upon the slopes of the mountains would rapidly run off into streams. While direct evaporation from the ground not sheltered by forest cover may become greater, yet the more rapid run-off and the absence of transpiration by trees would necessarily reduce the total amount of water evaporated into the atmosphere. The land, were it even taken up for agriculture, would not return such large quantities of rain into the atmosphere as the forests did. The inevitable result would be that less moisture would be carried by the prevailing winds into the interior of the country, and therefore less precipitation would occur there. Such is the influence of forests in a level or a hilly country.

Whether forests in the mountains have the same effect as forests in level countries upon the precipitation of the regions into which the prevailing winds that pass over them blow, is difficult to determine. The problem is more complicated for the reason that high mountain chains exert an influence upon the direction of the winds, not only by presenting a mechanical obstruction to the free passage of the air, but also on account of the difference in the heating of the different slopes. A moist current of air in passing over a mountain chain undergoes several changes. It is known that the air in ascending becomes cooler. The temperature of not fully saturated air decreases 1° F. for every 182

feet of ascension. In ascending the mountain slope the water-holding capacity of the air decreases until the saturation point is reached, and fogs, clouds and precipitation begin to form. The further cooling of the air is counteracted to some extent by the heat that is given off in the process of the condensation of vapor. This further cooling, therefore, proceeds only at the rate of about 0.5° F. for every 182 feet of ascension, or only half as much as when the air is dry. After the air current has passed the crest of the mountain and lost an amount of moisture corresponding to the temperature which it had at the time of passage, it descends on the leeward side and becomes heated.

In its descent it absorbs the fogs and clouds. In this process it consumes some heat. The further heating goes on at the rate of 1° F. for every 182 feet of descent. The more moisture there is extracted on the windward side of the slope, the greater is the temperature of the air on the leeward side.

If, for instance, an air current before ascending had a temperature of 50° F. at a barometric pressure of 30 inches, and the crest over which it passed was 9,900 feet high, then, on the leeward side at the same altitude at which it began to ascend, it would not have a temperature of 50° F., but of 77° F. at a relative humidity of 21 per cent. At other ascensions by the same current of air, the same changes would take place. But new precipitation, as a rule, begins on the next chain of mountains only at an altitude equal to that of the crest of the previous mountain chain over which the current of air has passed.

Professor Mayr[5] has shown that wherever there are several parallel chains of mountains perpendicular to the moist-air current, such as are found on the Pacific coast, of which each one is higher than the previous one, the forest appears in each consecutive mountain chain only from an altitude equal to the altitude of the top of the preceding chain over which the air current has passed. Between the mountain chains there remain treeless, dry valleys. This is strikingly observed in the Pacific coast and Rocky Mountains, as well as in Caucasus and Turkestan.

[5] "Waldungen von Nord Amerika."

As a rule, the moist air currents, in passing over wooded slopes, being chilled, deposit most of their precipitation on the windward side. It is only in exceptional cases, such as when the air that passes over the wooded slopes is not fully saturated, or when warm currents rise from below, that the air current, instead of depositing moisture, becomes enriched with moisture and carries it over the crest to the regions lying farther on its way.

This may occur on southern slopes, which are apt to become warm. The influence of wooded windward slopes upon the humidity of the regions lying to the leeward side of the mountain chains, therefore, varies. It is apparent, however, that, while the forests in the mountains at right angles to prevailing moist winds have a marked influence upon local precipitation, their influence upon the humidity of regions lying to the leeward of them can not, on the whole, be very great.

CONCLUSIONS

If the effect of mountainous forests upon the precipitation of regions lying in the lee of them is not entirely clear to us, the effect of forests in wide plains of continents, especially in the path of moist winds, can not be doubted. By increasing the evaporation from the land at the expense of surface run-off they enrich with moisture the passing air currents, and in this way help to carry it in larger quantities

into the interior of continents. The destruction of such forests, especially if it leaves the ground bare or partly covered with only weak vegetation which does not transpire large quantities of water, must inevitably affect the climate, not so much the climate of the region in which the destruction took place but the drier regions into which the prevailing air currents flow.

I realize, of course, that direct proof of this climatic influence quantitatively expressed is still lacking. It will take many decades before direct observations of such a character will be secured. If, however, the premises upon which the discussion rests, namely, that the precipitation of the eastern half of the United States is intimately connected with the prevailing south winds, that evaporation from land contributes more to the precipitation over land than evaporation from the ocean, that forests evaporate more water than free water surface, or any other vegetation, then forests in the path of prevailing winds must necessarily act as distributors of precipitation over wide continents.

What practical deductions can be made from these facts?

1. Forests must be protected not so much in localities which already suffer from lack of moisture as in regions which lie in the path of prevailing winds and are still abundantly supplied both with ground water and precipitation. In the dry regions large bodies of forests may have the opposite effect upon the available water supply. There only forests growing along rivers may contribute to the humidity of the region. There rows of trees or windbreaks surrounding fields and orchards, by preventing the drifting of the snow and decreasing the activity of the wind, will act more as conservers of moisture in the soil than solid bodies of timber. Therefore, the care with which forests should be protected in the eastern half of the United States must increase from north to south and from west to east.

2. In the Atlantic plain and southern Appalachians, which are the gateway for the prevailing winds from the Gulf of Mexico and the Atlantic Ocean, forests must be especially maintained.

(*a*) On moist soils, provided the excess of water or the substances contained in it do not prevent their development, because the moister the soil on which forests grow the more moisture they evaporate. For this reason swamps, since they contribute less to the moisture contents of the air than crops or forests and lose considerable water by surface run-off, must be drained, as by doing this an increase of the evaporation at the expense of surface run-off may be secured.

(*b*) On sandy soils. Forests on sandy soils readily absorb water through the roots and evaporate it into the atmosphere. Denuded of forest cover, sandy soils readily absorb rainwater which percolates into the ground and often reaches the sea by underground channels without being returned to the atmosphere.

(*c*) On steep slopes and rocky places; the removal of forests on such places inevitably leads to an increase in the surface run-off and to a corresponding decrease in local evaporation.

3. If clearing of the forest is a necessity it should be done only under condition that the cleared land is to be devoted to intense cultivation, as, after forests, crops contribute most to the moisture of the air. The highest organic production, therefore, is in harmony with the safeguarding of the humidity in the regions which lie in the path of the prevailing winds. Cleared land that becomes waste or poor pastures or grows up to weak vegetation, means so much evaporation lost to the passing air currents.

The effect of forests upon climate, if viewed as a local influence, must necessarily be insignificant. First we must not forget that whenever we compare a forest with an open field adjoining it, the open field itself is under the influence of the forest and can not give a proper conception of the true effect of the forest.

Such a meteorological authority as Lorenz Liburnau, at the end of his monumental work on "The Results of Forest Meteorological Observations," remarks that his data and conclusions apply only to the influence which the forest exerts while it exists, but do not extend to conditions which may rise upon its complete destruction. "If, for instance, according to our observations in the Carpathian foothills, it appears that the influence of the forest upon the neighboring country is only insignificant, this does not indicate that a complete destruction of all the existing forests will produce here also only insignificant climatic changes. Very likely that, if the forest were completely destroyed, the difference would be much greater than the difference that exists now between the climate of the forest and its neighboring areas."

Local observations, no matter how accurately and minutely carried out, can not lead us to the solution of the problem. The method of attack itself is wrong. It is only by approaching the problem from a much broader standpoint, by rising mentally to a height which opens wide perspectives both to the distant shores of the Gulf of Mexico and the Atlantic Ocean and to the most interior portions of the continent; only by following the moist south winds on their way from the gulf through the gateway of the North American continent, the Atlantic plain to the Prairie region, by considering how many times the moisture carried by the wind is dropped in the form of precipitation and raised again as evaporation, by studying the part which the vegetative cover plays in this circulation of water on the land, especially the dense coniferous forests, that we can grasp the problem in its true light.

RAPHAEL ZON

U. S. FOREST SERVICE

LESTER FRANK WARD

LESTER FRANK WARD, A.B., LL.B., A.M., LL.D., was born at Joliet, Illinois, June 18, 1841, and died in Washington, D. C., April 18, 1913.

Philosopher, sociologist, paleobotanist—few men in these days of specialization have earned such enviable reputation along such widely divergent lines of thought as are designated in these terms, which imply both a deep thinker on abstract subjects and a careful student of concrete facts. The scope of his mentality was remarkable, not alone in the ability to master any subject in which he chanced to become interested, but also in the ability to completely dismiss any subject from his mind whenever he wished to concentrate attention on something entirely different, and to subsequently resume the original trend of thought without apparent effort.

His reputation as a student of and writer on ethical and sociological subjects assures that he will not be forgotten or fail of suitable recognition by those who are best qualified to discuss his activities in such connection. It is my privilege to merely say a few words in regard to Dr. Ward as a paleobotanist.

Our personal acquaintance began in 1882, about a year after his appointment as assistant geologist on the staff of the United States Geological Survey. His special work was in connection with the problems of paleobotany and their relations to geological investigations, the importance of which was just beginning to attract some attention, and it was my good fortune to enlist his interest and to subsequently enjoy the privilege of his cooperation and kindly criticism in my paleobotanical studies and to feel the inspiration of his con-

scientious and careful methods of procedure, for a period of almost thirty years.

Dr. Ward possessed a good working knowledge of botany and geology at the time when he entered upon his duties in the Survey, and it is interesting to note that one of the earliest of his published works was a "Guide to the Flora of Washington and Vicinity"—the fruit of his many local tramps and explorations from which he derived the keenest pleasure. Several short articles, published in the *American Naturalist* and elsewhere, had preceded this, two of which "On the Natural Succession of the Dicotyledons" and "Homologies in the Lauraceæ," may be cited as foreshadowing the philosophical and evolutionary tendency of the works that were to follow. The drift into paleobotany was almost inevitable, even had it not been included in the line of official duties. Among the titles of papers which appeared in rapid succession, for example, were such as "Evolution in the Vegetable Kingdom," "The Ginkgo Tree," "The Paleontologic History of the Genus *Platanus*," "Historical View of the Fossil Flora of the Globe," "Geological View of the Fossil Flora of the Globe," "Botanical View of the Fossil Flora of the Globe," "Sketch of Paleobotany," "Geographical Distribution of Fossil Plants," etc. The two last mentioned are exhaustive dissertations which are standard works of reference for all who are interested in the bibliography and general principles of the subject and the recorded localities in which fossil plants have been found in the different parts of the world. These two works, issued in 1885 and 1888, respectively, demonstrate in a striking manner the wide acquaintance with paleobotanical literature which he had already acquired, and the wealth of such material which he had so rapidly gathered together. The pioneers of the science in America—Dawson, Newberry and Lesquereux—had blazed the way; but it remained for Dr. Ward to realize the necessity for systematic preparation in order to insure accuracy and to place the science on a firm and dignified footing which would win for it the recognition that it deserved. With his tireless energy and persistence he gradually gathered together, largely through personal correspondence and exchange, all obtainable works directly or indirectly treating of fossil plants, and thus built up a library which, with recent additions, is to-day, without doubt, the most complete of its kind in the world.

He also foresaw the necessity of having at hand, for ready and accurate reference, an index of the genera and species of fossil plants and their places of publication. He fully realized the years of hard work, both mental and mechanical, which the undertaking involved, with but little to show as an ultimate result which would be appreciated or even understood by any except the limited number of persons actively interested in paleobotanical investigations. Nevertheless it was undertaken and has been successfully continued and elaborated and brought up to date; and it is no exaggeration to say that the accuracy and completeness which characterize the paleobotanical publications of the Survey are in large measure due to this work, conceived and begun by Dr. Ward. It includes some 80,000 references to descriptions and illustrations of fossil plants, and a bibliography of about 12,000 titles by about 2,000 authors. Dr. Ward's titles alone, including reviews, number about one hundred and fifty. Critical paleobotanical work in America can not be prosecuted without its aid, and all American students and writers on the subject must, at times, consult it and the library connected with it, in order to obtain information nowhere else available.

The relations of fossil plants to geology, and their value and importance in stratigraphic investigations, were discussed and indicated in many of Dr. Ward's more extended works, such as "Synopsis of the Flora of the Laramie Group," "Evidence of the Fossil Plants as to the Age of the Potomac Formation," "The Plant-bearing Deposits of the American Trias," "Principles and Methods of Geologic Correlation by Means of Fossil Plants," "Status of the Mesozoic Floras of the United States," etc. He also contributed the article on Fossil Plants for Johnson's Encyclopedia

in 1895, and the botanical and paleobotanical definitions for the Century Dictionary.

Dr. Ward had a wonderful faculty for coordinating and systematizing facts and information. The former were always clearly stated and presented in logical sequence, and the arrangement of his text was always carefully thought out. His guiding principle in all his writings was that he was not writing for himself, but for others, and he always tried to place himself in the position of those who would have occasion to read or consult or cite what he had written. The consequence is his works may be easily read, or quickly referred to, or accurately cited in any particular.

His influence and example as a systematic, orderly, and conscientious worker and writer have left an indelible impression upon all who were associated with him and will be felt, consciously or unconsciously, by all who may follow in his footsteps.

ARTHUR HOLLICK

NEW YORK BOTANICAL GARDEN,
June 30, 1913

GERMAN AND SWISS UNIVERSITY STATISTICS

THE preliminary statistics of the number of students enrolled in German universities during the winter semester of 1912–1913 (Deutscher Universitätskalender, 83. ed.) show that the total number of matriculated students amounted to 58,844 as against 58,672 in the summer semester of 1912. Including auditors the totals are 64,590 and 63,351, respectively. Of the auditors registered in the winter semester 3,997 were men and 1,749 were women, while of the matriculated students, no less than 3,213 were women, these being distributed by faculties as follows:

Theology	11
Law	79
Medicine	715
Philosophy	2,408

The following universities attracted the largest number of women students:

Berlin	904
Bonn	289
München	262
Göttingen	237
Heidelberg	219
Freiburg	189
Münster	172
Breslau	150
Leipzig	129
Marburg	126

It may be interesting in this connection to call attention to some statistics recently published by the French Ministry of Education, showing that the percentage of women students in France in 1912 was 9.8 per cent. as against 4.8 per cent. in Germany.

Excluding the emeritus professors, the faculties of the German universities in the summer semester of 1913 are manned by 1,306 full professors, 131 honorary full professors, 788 adjunct professors, 3 honorary adjunct professors and 1,210 docents.

The matriculated male students enrolled in the winter semester were distributed by faculties as follows:

Protestant theology	3,386
Catholic theology	1,785
Law	11,376
Medicine, pharmacy and dentistry	15,309
Philosophy	26,988

The largest number of matriculated students, namely, 9,806, was enrolled at the University of Berlin, this institution being followed by the remaining 20 institutions in the following order:

München	6,759
Leipzig	5,351
Bonn	4,179
Halle	2,906
Breslau	2,710
Göttingen	2,660
Freiburg	2,627
Heidelberg	2,264
Münster	2,154
Marburg	2,076
Strassburg	2,063
Tübingen	1,898
Jena	1,842
Kiel	1,738
Königsberg	1,616
Würzburg	1,455
Giessen	1,338

Erlangen	1,261
Greifswald	1,260
Rostock	881

The largest faculties of Protestant theology range in the following order:

Berlin	555
Leipzig	466
Halle	401
Tübingen	336

For the largest Catholic schools of divinity the order is as follows:

Bonn	400
Münster	305
Breslau	269
Freiburg	225

The University of Berlin possesses the largest schools of law (2,280) and philosophy (4,732), being followed in law by München (1,165), Leipzig (892), Bonn (846), Breslau (535) and Freiburg (519); in philosophy by Leipzig (2,832), München (2,347), Bonn (2,156), Göttingen (1,740) and Halle (1,642).

The University of München leads in medicine with 2,287 matriculated students, to which must be added 203 in pharmacy and 94 in dentistry; Berlin follows with 2,239 students; then come Freiburg with 1,029 students (plus 35 pharmacists), Leipzig with 947 (plus 136 pharmacists and 78 dentists), Heidelberg with 734, Bonn with 652, Breslau with 641, and Würzburg with 615 (plus 76 dentists and 47 pharmacists).

The largest enrollment of foreigners during the winter semester of 1912–13 was found at the University of Berlin, where 1,605 matriculated foreigners were enrolled. Berlin was followed by

Leipzig	784
München	687
Halle	315
Heidelberg	264
Königsberg	244
Strassburg	191
Freiburg	177
Göttingen	174
Breslau	162
Bonn	144
Jena	140

Altogether there were 5,193 matriculated foreigners enrolled at the German universities; of these 4,648 hailed from Europe, 338 from America, 184 from Asia, 22 from Africa and 1 from Australia. Of the Americans 171 studied at Berlin, 36 at München, 31 at Göttingen, 21 at Heidelberg and 20 at Leipzig. Of the European countries, Russia had the largest number of representatives, namely, 2,840, of whom 641 were enrolled at Berlin, Russia being followed by

Austria	900
Switzerland	340
Roumania	156
Great Britain	145
Bulgaria	111
Greece	100
Turkey	78
Servia	61
Luxembourg	58
France	53
Holland	47
Italy	39
Sweden	27
Spain	25
Norway	20
Belgium	19
Denmark	13
Portugal	10
Montenegro	1

The number of students matriculated at the seven Swiss universities in the winter semester of 1912–13 amounted to 7,019 as against 7,226 in the summer semester of 1912. 53.33 per cent. of these students hailed from Switzerland, 30 per cent. from Russia and the Balkan States, 10 per cent. from Germany and Austria, 2.5 per cent. from France and Italy, and 4.4 per cent. from other countries. No country in the world has as large a percentage of foreign students at its institutions of higher learning as Switzerland has.

Rudolf Tombo, Jr.
Columbia University

CONTRIBUTIONS TO GENERAL GEOLOGY

Of late years survey authors have become contributors to scientific and technical journals to an extent that suggests the need of an official channel for papers of a certain type.

Participation in contributions to these outside journals is a valuable phase of the survey's activity and should continue, but this method of publication has certain limitations by reason of both the capacity and the circulation of these journals. It appears, therefore, that the time has come to begin the issue of an annual volume in the survey series that will afford opportunity for publication of short papers and preliminary reports of a character not well adapted to any of the present forms of publication.

It is significant that so many of the geologists are making scientific contributions of general interest that represent results incidental to other investigations or that are of the nature of by-products in strictly economic work. In order to develop greater breadth of observation and investigation among the geologists of the survey and to promote the scientific possibilities of their professional work means should be provided for prompt publication of such papers in a permanent form that will commend itself to the author and to the scientific reader alike. Provision has been made since 1902 for the current publication of short papers relating to economic geology, and the time is opportune for a similar provision for scientific papers relating to general geology.

It is proposed to issue an annual volume in the Professional Paper series, entitled "Contributions to General Geology" (short papers and preliminary reports).

In advance of the printing of the full volume, separates, each including one or more papers, will be issued to the number of ten or twelve a year as the manuscript and illustrations are ready, without waiting for material for the full volume to be in hand or even promised. The papers included in these "Contributions to General Geology" may relate to any phase of geology, provided it possesses general interest—petrology, paleontology, stratigraphy, glaciology, structural geology, etc. This volume is intended not as a catch-all for current odds and ends, but as a dignified collection of scientific contributions, each worthy in importance of subject, value of results and quality of treatment for separate publication as a bulletin or professional paper if it were of sufficient length. Two papers before me which will probably be included in the first separate of the 1913 "Contributions" are Mr. Shaw's "Mud Lumps at the Mouths of the Mississippi" and Mr. Gale's "Origin of Colemanite Deposits." Illustrations in this publication, as in the "Contributions to Economic Geology," should be few in number and confined to line cuts and halftones, for prompt publication is essential. The date of actual publication will be printed on the title-page of each separate.

The chief geologist will begin to receive manuscripts at once, in the hope that several separates may be issued between July and December, and that the 1913 volume may be published early in January, when the first separate for 1914 will also be expected.

Geo. Otis Smith,
Director

MEDICAL RESEARCH IN GREAT BRITAIN[1]

Mr. Lloyd George, as minister responsible to parliament for National Health Insurance, has appointed the following persons as a committee with executive functions, to be known as the Medical Research Committee, for the purpose of dealing with the money made available for research under the National Insurance Act:

The Right Hon. Lord Moulton of Bank, LL.D., F.R.S. (chairman).

Christopher Addison, M.D., F.R.C.S., M.P.

Waldorf Astor, M.P.

Sir T. Clifford Allbutt, K.C.B., M.D., F.R.C.P., F.R.S., regius professor of physic, University of Cambridge.

Charles John Bond, F.R.C.S., senior honorary surgeon, Leicester Infirmary.

William Bulloch, M.D., F.R.S., bacteriologist to the London Hospital and professor of bacteriology in the University of London.

Matthew Hay, M.D., LL.D., professor of forensic medicine and public health, Aberdeen University.

Frederick Gowland Hopkins, M.B., D.Sc., F.R.S., reader in chemical physiology in the University of Cambridge.

[1] From the London *Times*.

Brevet Colonel Sir William Boog Leishman, M.B., F.R.S., professor of pathology, Royal Army Medical College.

These first appointments are for three years in each case; in and after 1916 three members, to be selected in manner to be prescribed, shall retire at intervals of two years, their places being filled (whether by reappointment or otherwise) by the minister responsible for National Health Insurance.

The duties of the committee will be to formulate the general plan of research and inquiry at the outset and for each year, to make arrangements for carrying it out, and to supervise its conduct so far as may be necessary, and in particular to secure adequate coordination of the various parts of the scheme. The committee will also deal with the collection and publication of information, and of the results of statistical and other inquiries so far as suitable or necessary. For this purpose it will determine, subject to the assent of the minister responsible for National Health Insurance, the expenditure of the money available each year, the total of the sums available under paragraph (*b*) of subsection (2) of section 16 of the Act being about £57,000 per annum. Before the minister responsible for National Health Insurance gives his final assent to the Medical Research Committee's scheme for any year, he will receive criticisms and suggestions in regard to it from the Advisory Council for Medical Research.

This Advisory Council has been appointed for the purpose by Mr. Lloyd George, as minister responsible for National Health Insurance, after receiving suggestions for suitable names from each of the universities of the United Kingdom, from the Royal Colleges of Physicians and of Surgeons, from the Royal Society, and from other important public bodies interested in the question. It includes medical representatives of the four National Health Insurance Commissions, and the other principal government departments concerned in medical work. The first appointments are for three years in each case; in and after 1916 one third of the members, to be selected in manner to be prescribed, shall retire at intervals of two years, their places being filled (whether by reappointment or otherwise) by the minister responsible for National Health Insurance.

The duty of the Advisory Council will be to consider the scheme of the Medical Research Committee, when referred to them, as above explained, and to afford to the minister all such criticisms and suggestions in regard to it as they may think desirable to submit to him from the point of view of securing that adequate consideration is given to the different problems arising and the various kinds of research work going on in the different parts of the United Kingdom and in other portions of the empire, in America, and in foreign countries, and also to the general scope of the research work to be undertaken under the committee's scheme.

The membership of the Advisory Council for Medical Research is as follows:

The Right Hon. Lord Moulton of Bank, LL.D., F.R.S. (chairman), Miss L. B. Aldrich-Blake, M.D., M.S., Sir W. Watson Cheyne, Bt., C.B., F.R.C.S., F.R.S., Sir William S. Church, Bt., K.C.B., M.D., Sidney Coupland, M.D., David Davies, M.P., Sheridan Delépine, M.B., Sir James Kingston Fowler, K.C.V.O., M.D., Sir Rickman J. Godlee, Bt., F.R.C.S., Sir Alfred Pearce Gould, K.C.V.O., F.R.C.S., David Hepburn, M.D., Arthur Latham, M.D., Sir John McFadyean, M.B., W. Leslie Mackenzie, M.D., J. C. McVail, M.D., W. J. Maguire, M.D., S. H. C. Martin, M.D., F.R.S., Robert Muir, M.D., Alexander Napier, M.D., Sir George Newman, M.D., Arthur Newsholme, C.B., M.D., J. M. O'Connor, M.B., Sir William Osler, Bt., M.D., F.R.S., A. C. O'Sullivan, M.B., Marcus S. Paterson, M.D., Sir Robert W. Philip, M.D., Sir William H. Power, K.C.B., F.R.C.S., F.R.S., H. Meredith Richards, M.D., Lauriston E. Shaw, M.D., Albert Smith, M.P., J. Lorrain Smith, M.D., F.R.S., T. J. Stafford, C.B., F.R.C.S.I., T. H. C. Stevenson, M.D., Harold J. Stiles, F.R.C.S., Edin., Sir Stewart Stockman, M.R.C.V.S., W. St. Clair Symmers, M.B., Miss Jane Walker, M.D., Norman Walker, M.D., J. Smith Whitaker, M.R.C.S., L.R.C.P., Sir Arthur Whitelegge, K.C.B., M.D., G. Sims Woodhead, M.D.

THE EDUCATIONAL FUND COMMISSION OF PITTSBURGH

THE Educational Fund Commission of Pittsburgh, to which was intrusted one quarter of a million dollars some five years ago, for the betterment of teachers and teaching in the public schools, has now made the awards for this year, making a total of about four hundred and seventy-five that this commission has sent out for study during the past four years. The chairman of the commission, Dr. John A. Brashear, writes:

I think I can readily say that ninety-five per cent. of these teachers have brought back value received to our public schools in the way of efficiency. We do not ask these teachers to work hard, preferring that they take a very small number of studies and enjoy a part of their time in rest, recreation and recuperation. Nor do we lay great stress on the purely intellectual side of their work, preferring that they bring back to us efficiency in the way of improving home life, social, moral and physical betterment. This they have not only done in the past, but through the splendid influence of their associations have distributed the good they have received in their summer studies among their fellow teachers in our great school system.

I am also pleased to report that the deans of the various summer schools have received our Pittsburgh teachers with very great kindness, indeed, to such an extent that perhaps fifty per cent. of them return the following year to study upon their own initiative and pay their own summer tuition and expenses.

I wish I could give you the name of the donor, but notwithstanding the great work done for the public schools of Pittsburgh, he insists that his name remain anonymous.

The summer schools for which scholarships were given, and number of teachers to be sent to each school by the Educational Fund Commission is as follows:

Harvard University	16
Columbia University	15
Chautauqua	14
University of Pittsburgh	16
Carnegie Institute of Technology	13
University of Wisconsin	11
Cornell University	14
University of Michigan	7
University of Chicago	4
University of Colorado	2
University of Pennsylvania	3
Cape May School	5
Pennsylvania State College	5
Dartmouth	3
Zanerian College	3
Syracuse University	2
Northwestern University	1
New York University	1
Johns Hopkins University	1
Boothbay Harbor	1
Art Institute, Chicago	1
Vineland Training School	1
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THE ROCHESTER MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE forty-eighth annual meeting of the American Chemical Society will be held in Rochester, New York, September 9 to 13, inclusive. A meeting of the council will be held on Monday night, September 8, at the Hotel Seneca, immediately following the complimentary dinner to be given to the council at seven o'clock.

The program will open with a general meeting on Tuesday at 10 A.M., in the assembly hall at Kodak Park. The members of the society are to be the guests of the Eastman Kodak Company at luncheon following the morning meeting, and the afternoon will be spent in visiting the immense plant of the Eastman Kodak Company at Kodak Park.

A smoker will be held at 8:30 P.M., Tuesday, in Masonic Hall. The divisional meetings on Wednesday, all day, and Thursday and Friday mornings, will be held in the Eastman building, University of Rochester. The president's address will be given at the East High School, Rochester, at 8 P.M., Wednesday; and the subscription banquet, Thursday night at 7 P.M., at Powers Hotel.

On Thursday and Friday afternoons, excursions will be open to the following manufacturing plants:

Bausch and Lomb Optical Co.,
Taylor Instrument Co.,
Curtice Bros. Co.
J. Hungerford Smith Co.,

Moerlback Brewery,
German-American Button Co.,
Genessee Reduction Co.,
Municipal Incinerator,
Stecker Lithographic Co.,
and possibly others.

The following are the addresses of the divisional and sectional secretaries:

Industrial Division—S. H. Salisbury, Jr., Lehigh University, South Bethlehem, Pa.

Physical and Inorganic—R. C. Wells, U. S. Geological Survey, Washington, D. C.

Fertilizer—J. E. Breckenridge, Carteret, N. J.

Agricultural and Food—G. F. Mason, care of Heinz Company, Pittsburgh, Pa.

Organic—Wm. J. Hale, University of Michigan, Ann Arbor, Mich.

Pharmaceutical—Frank R. Eldred, 3325 Kenwood Ave., Indianapolis, Ind.

Rubber—Dorris Whipple, care of The Safety Insulated Wire and Cable Co., Bayonne, N. J.

Biological—I. K. Phelps, Bureau of Mines, 40th and Butler Sts., Pittsburgh, Pa.

SCIENTIFIC NOTES AND NEWS

Dr. Joseph Swain, president of Swarthmore College, was elected president of the National Educational Association at its recent Salt Lake City meeting. Dr. Robert J. Aley, president of the University of Maine, was elected president of the National Council of Education.

The fourteenth series of the Lane medical lectures will be given by Professor Sir Edward Schäfer, professor of physiology, University of Edinburgh. These lectures will be upon "The Functions of the Ductless Glands especially in relation to other Secreting Organs." They will be delivered on the evenings of September 3, 4, 5, 8 and 9, in the Lane Hall of the Stanford University Medical Department, San Francisco.

The Berlin Academy of Science has awarded its gold Leibnitz medal to Professor Georg Schweinfurth for his explorations and researches in Africa.

Professor Rudolf Sturm, the distinguished mathematician of the University of Breslau, has celebrated the fiftieth anniversary of his doctorate.

Mr. William Stanley, of Great Barrington, Mass., electrical inventor and engineer, has received the Edison gold medal awarded by the American Institute of Electrical Engineers for meritorious achievement in electricity.

The Michigan Agricultural College has conferred the degree of doctor of science upon Mr. William A. Taylor, chief of the bureau of Plant Industry, United States Department of Agriculture.

Dr. Erwin F. Smith, plant pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, has been awarded a certificate of merit by the American Medical Association. This was consequent upon an exhibit made by Dr. Smith at the recent annual meeting of association at Minneapolis illustrative of the results of his researches upon cancer in plants. On June 28 Dr. Smith delivered an address upon this subject at the University of Wisconsin under the auspices of the Department of Plant Pathology.

Dean W. F. M. Goss, of the engineering college, University of Illinois, has been granted leave of absence for one year beginning July 1, 1913, to enable him to serve as chief engineer to the Chicago Association of Commerce committee on the investigation of smoke abatement and the electrification of railway terminals.

Dr. J. S. Flett, F.R.S., assistant director, Geological Survey of Great Britain; Dr. A. Lacroix, professor of mineralogy, Natural History Museum, Paris, and Professor E. Weinschenk, Munich, have been elected life honorary members of the Geological Society of South Africa.

The alumni of Adelbert College, Western Reserve University, at the last commencement adopted the following resolution:

Whereas: Charles J. Smith has continuously filled the chair of mathematics in this college for a period of forty-three years and is about to relinquish the duties of an active professor, and

Whereas: The alumni thereof duly appreciate his long and honorable career as such professor and the personal benefits they have derived from his instruction,

Resolved, That we, the alumni of Adelbert College of Western Reserve University, express our deep appreciation of his scholarly attainments, the benefits we have derived from his instruction and our affectionate regard for him as a man, our hope that he may be spared for many years to enjoy the fruits of his life's work, and that the secretary of this alumni association be instructed to place in Professor Smith's hands a copy of this resolution.

DR. M. W. TWITCHELL, formerly professor of geology at the University of South Carolina and now assistant state geologist of New Jersey, has returned from two months' leave of absence, during which he served as acting professor of geology at the University of Colorado, while Professor R. D. George was engaged upon other duties as state geologist of Colorado.

PROFESSOR H. A. GLEASON, assistant professor of botany, University of Michigan, will leave in September for a year's travel, during which he will visit Australia, the Philippines, Java and Ceylon.

PROFESSOR H. E. GREGORY, of Yale University, has been studying the geology and water resources of the Navajo Reservation, in parts of New Mexico, Arizona and Utah, under the auspices of the U. S. Geological Survey.

IT is proposed to commemorate in 1914 the seventh centenary of Roger Bacon's birth by erecting a statue in his honor in the Natural History Museum at Oxford, and by raising a fund for the publication of his works.

DR. HORACE JAYNE, formerly professor of vertebrate morphology in the University of Pennsylvania, dean of the college and of the faculty of philosophy, and director of the Wistar Institute, died on July 8, aged fifty-four years.

DR. PHILIP LUTLEY SCLATER, from 1859 to 1902 secretary to the Zoological Society of London, distinguished for his work on the systematic zoology of birds and mammals and on geographic distribution, died on June 27, aged eighty-four years.

NEW YORK state civil service examinations will be held on July 26, as follows: In the State Department of Highways—for division engineer at a salary of $4,000 a year; for superintendents of construction and maintenance at salaries of from $2,500 to $3,000; for chiefs of construction and maintenance at salaries of $4,000 a year. In the office of the state architect—for heating engineer at a salary of $1,500 to $2,500 a year; for sanitary engineer at a salary of $2,000 to $2,500, and for electrical draftsman at a salary of $1,500 to $1,800. Examinations will also be held for the position of bridge designer at a salary of $1,500 to $2,100 and of junior bridge draftsman at a salary of $900 to $1,200. Application blanks can be obtained from the office of the commission at Albany until July 16.

MRS. A. H. CLARKE, of Earl's Court, has given to the University of London the collection of continental and exotic macrolepidoptera made by her late husband, who was one of the senior fellows of the Entomological Society. The section of exotic butterflies consists of nearly 6,000 specimens from all parts of the world, and is particularly valuable as a reference collection, not merely from the number and careful selection of the forms represented (some being of great rarity), but from the perfect condition and beauty of the specimens themselves. The whole donation comprises over 12,000 specimens all carefully set, arranged and labeled; and to it Mrs. Clarke has added her husband's working library of entomological literature. After the work of arranging and cataloguing has been concluded, the collections will be available for reference by entomologists generally upon application to the professor of zoology at the university.

THE Board of Agriculture of Ceylon has appointed a committee in London to arouse public interest in the establishment of an Imperial Central College of Tropical Agriculture in the far east. At the annual meeting of the Ceylon Association, held on June 12 in the Chamber of Commerce, London, it was unanimously resolved that the association approved

of Peradeniya, Kandy, as the best site for the proposed college. It was stated that the Peradeniya Gardens are uniquely situated for the purpose. The local climate is excellent. In every direction are vast plantations of all kinds of tropical products, which afford splendid opportunities for studying estate work on the spot. The whole of Ceylon, in fact, is devoted to every variety of tropical agriculture. Another great local advantage is that the student would find himself in continual contact with the Tamil—the Indian agricultural laborer of the east and of most tropical colonies.

The London *Times* states that the *Terra Nova*, which arrived at Cardiff on June 14, carried the natural history collections of the Scott Antarctic Expedition which fill nearly 200 cases. These have been transferred to the Natural History Museum at South Kensington. The collections are of high scientific interest. Perhaps the most important, and from the personal point of view certainly the most precious, is the collection of fossils discovered by Captain Scott and Dr. Wilson during their ill-fated return journey from the South Pole. This box of fossils was found on a sledge when the relief party arrived at the place where Captain Scott and his brave companions perished. The whereabouts of the sledge was indicated by a pole which Captain Scott had erected, knowing that the sledge would be hidden by snow. The box is at present intact. The other collections comprise birds (including many penguins), seals and whales. There is a very large and extensive collection of marine specimens—crustaceans, molluscs, echinoderms, etc. The botanical specimens are numerous, and there are many mosses and lichens. The collection as a whole is very much larger than that which was brought home by the *Discovery*. It bears testimony to the care with which Captain Scott organized his expedition, and to the thoroughness with which his plans for its scientific work have been carried out. The results, when fully described, can not fail to add largely to our knowledge of the natural history and the past climatic conditions of the Antarctic regions.

The eighty-first annual meeting of the British Medical Association will be held at Brighton on July 22, 23, 24 and 25, under the presidency of Dr. William Ainslie Hollis. Sixteen scientific sections have been arranged and will meet daily, namely, Bacteriology and Pathology; Climatology and Balneology; Dermatology; Diseases of Children, including Orthopædics; Electro-therapeutics; Gynæcology and Obstetrics; Laryngology, Rhinology and Otology; Medical Sociology; Medicine; Navy and Army and Ambulance; Neurology and Psychological Medicine; Ophthalmology; Pharmacology, Therapeutics and Dietetics; State Medicine; Surgery, and Tropical Medicine. On July 23, Professor George R. Murray will deliver an address on medicine; on July 24, the address on surgery will be delivered by Sir Berkeley Moynihan, and on July 25, a popular lecture with cinematograph illustrations, entitled "Some Wonders of Animal and Plant Life in Pond and Pool," will be delivered by Mr. Edmund Johnson Spitta.

The Australian Institute of Tropical Medicine at Townsville, which was founded as the result of an amalgamation of the schemes of Professor Anderson Stuart, of Sydney, and of the ex-Bishop of North Queensland, and now mainly supported by the commonwealth, was opened on June 28 by Sir William Macgregor. The Australian Universities, in conjunction with the institute, grant a diploma in tropical medicine.

At the last session of the legislature of Maine a continuous annual appropriation of $5,000 was made to the Maine Agricultural Experiment Station for "investigations in animal husbandry." The event is chiefly notable because of the fact that this is the first money ever appropriated by the state to the experiment station for the direct support of work of investigation. Hitherto all support of research has come from federal (Hatch and Adams) funds. The added funds were specifically appropriated and will be used for the extension of the investigations in the field of genetics,

carried on by the department of biology in charge of Dr. Raymond Pearl. The department has been accorded additional laboratory space in the station building. The staff has been increased by the appointment of Dr. Frank M. Surface, formerly biologist of the Kentucky Agricultural Experiment Station, as biologist; and of Mr. John Miner, a graduate of the University of Michigan, where he specialized in the study of actuarial and statistical mathematics under the direction of Professor James W. Glover, as computer.

ON Friday, June 27, the new wing of the Rothamsted laboratories was opened. According to the account in *Nature* Mr. Runciman, president of the British Board of Agriculture, sketched the history of the Rothamsted Experiment Station from its beginning in 1843 to the present time. The experiments grew out of some pot trials made by Lawes as a young man in the late 'thirties. The first result was the discovery of superphosphate, which alone had proved of almost incalculable benefit to the world, markedly increasing the yields of some of the British and Continental crops, and rendering possible the economic growth of wheat in Australia. Feeding experiments on animals came later, and proved of fundamental importance both to farmers and physiologists. During the fifty-seven years of their partnership, Lawes and Gilbert had investigated most of the important problems connected with British agriculture, and laid the whole community under a great debt of obligation to them. The work thus begun had expanded considerably under Mr. Hall's directorship (1902–12), and the growth was such that the new wing was already full, and the director, Dr. Russell, was preparing plans for new buildings to be erected in commemoration of the centenary of the birth of Sir John Lawes (1814) and Sir Henry Gilbert (1817). Mr. Runciman expressed the hope that the centenary fund would be well and widely supported.

MR. GEO. OTIS SMITH, director of the U. S. Geological Survey, on June 30 addressed the following letter to members of the survey:

Secretary Lane to-day presented Mr. Brooks with the Conrad Maltebrun gold medal which he had received from Paris through the Secretary of State. In making this presentation Secretary Lane expressed himself so thoroughly appreciative of the investigative work of the survey that I regret that a stenographic report of his remarks is not available. He expressed himself as gratified that this honor had come to Mr. Brooks as the chief of the Alaskan division of the survey, and added that he, like his predecessors, had come to place large dependence upon Mr. Brooks's intimate knowledge of Alaska and its resources; and he regrets that such signal honors as this medal awarded by the Société de Geographie of Paris come so seldom to the workers in the government service.

Addressing also Messrs. White, Marshall, Grover and Spencer, who were present, Secretary Lane emphasized his appreciation of the fact that the Geological Survey and other branches of the Department of the Interior include among their members men who are giving their very best service to the government and are actuated by the highest patriotism. To-day at Gettysburg men are receiving the honor due them for their services of fifty years ago, but these men who are serving the government to-day are no less worthy of medals for heroism and of other honors, as well as old age pensions, than are the veterans of the civil war, but the day will surely come when due recognition will be given to the civil service. In the meantime, however, it will be the endeavor to recognize the worth of these leaders in scientific investigation and so far as possible to entice them away from outside employment where their remuneration would be larger.

In his response, Mr. Brooks told the secretary that he felt his indebtedness not only to his associates in the Alaskan work, but also to those in charge of the field branches of the survey, which have trained the geologists, topographers and engineers for service in Alaska, and thus made possible the success of these investigations. Others, he said, throughout the survey had done the work, and the medal had come to the chief of the Alaskan division.

THE zoological expedition to Colombia of the American Museum of Natural History returned early in May, after an absence of four months. As we learn from the *Journal* of the museum the objects of the expedition were first, to collect material for a habitat group illustrating the bird life of the Magdalena Valley; second, to complete the ornithological survey of the Colombian Andes, begun

in 1910; third, to ascertain definitely the limits of the so-called Bogotá region whence, for the past seventy-odd years specimens collected by natives, but unaccompanied by data of any kind have been received; fourth, to collect a series of topotypical specimens from the Bogotá region. The expedition included Mr. Frank M. Chapman, and Messrs. George K. Cherrie, first assistant, Louis Agassiz Fuertes, artist, Thomas Ring, Paul G. Howes and Geoffrey O'Connell, volunteer assistants. This party left Barranquilla on January 19, and during the voyage of twelve days up the Magdalena River to Honda, by taking advantage of every opportunity when the boat stopped for cargo or fuel, collected three hundred birds. Studies for the habitat group were made at El Consuelo, on the western slope of the Eastern Andes, 2,700 feet above Honda; from this point a superb view is had of the Magdalena Valley, through which the river winds picturesquely, while in the background the Central Cordillera rises crowned by the three great snow peaks, Tolima, Isabel and Ruiz, each of which has an approximate altitude of 18,000 feet. Having completed its work in this region, the expedition journeyed by mule to Bogotá, making this city its headquarters during the remainder of its stay in Colombia. From Bogotá it passed first to the eastward to Villivicencio, at the eastern base of the Andes, stopping *en route* at all favorable localities. On reaching Villivicencio, the section through the Andes from the Pacific coast to the upper drainage of the Orinoco was completed, and data are now in hand for the determination of the altitudinal life zones of the Colombian Andes. A month later the expedition returned to Bogotá and passed southward to Fusugasuga, encountering there entirely different species from those which it had met with in its journey to the eastward. In all, some 2,300 birds and about 100 mammals were secured, and the diversity and richness of the avifauna is illustrated by the fact that no less than 505 species of birds were secured during the comparatively brief period when the expedition was actually in the field.

At the annual meeting of the American Association for Cancer Research, May 5, 1913, the following resolution (the report of the committee on statistics and public education) was unanimously adopted: "It is the sentiment of this association that: (1) the present instruction of medical students in the symptoms and early diagnosis of cancer is seriously deficient; (2) the medical curriculum should include special lectures in the clinical departments dealing specifically with this subject; (3) the universities should provide competent lecturers in this subject to address the local medical societies; (4) the associate members of the association should be urged to take up the question of the proper methods of approaching the public on the subject of cancer; (5) the activities of this association should at present be chiefly confined to the education of the medical profession; (6) this resolution shall be sent to the deans of the medical schools and the secretaries of the state medical societies in the United States and published in the medical press."

UNIVERSITY AND EDUCATIONAL NEWS

Public bequests aggregating $170,000 are provided in the will of Charles D. Sias, of Boston. Dartmouth College, the University of Vermont and Montpelier, Vt., Academy will eventually receive $15,000 each.

Mrs. Gustavus F. Swift and her son, Mr. Edward F. Swift, of Chicago, recently gave $10,000 toward the maintenance of the college of engineering of Northwestern University—an annual contribution since the opening of the college of engineering in 1908. Mr. Joseph Schaffner, of Hart, Schaffner and Marx, of Chicago, has given $12,500 toward the maintenance of the school of commerce of the university.

Miss Jeanie Pollock, of Glasgow, has bequeathed £10,000 to Glasgow University for providing a materia medica research lectureship.

The Atlanta College of Physicians and Surgeons and the Atlanta School of Medicine have been consolidated under the name of the Atlanta Medical College.

Dr. John H. Long, professor of chemistry in Northwestern University since 1881, has

been appointed dean of the school of pharmacy of Northwestern University, to succeed the late Oscar Oldberg.

DEAN DAVID KINLEY, of the graduate school, University of Illinois, has been elected vice-president of the university for one year beginning July 1, 1913, at the meeting of the trustees on July 2. He succeeds Dr. T. J. Burrill, who retired from active duties last year.

ALEXANDER GEORGE MCADIE, professor of meteorology in the Weather Bureau and director of the California climate section, has been elected director of the Blue Hill Observatory and professor of meteorology at Harvard University.

DR. F. J. ALWAY, head professor of agricultural chemistry in the University of Nebraska and chemist of the Nebraska Agricultural Experiment Station, has been appointed professor of soil chemistry and chief of the division of soils in the University of Minnesota. Dr. Fred Upson, of the University of Chicago, has been appointed to succeed Dr. Alway in the University of Nebraska.

DR. JAMES R. NYDEGGER, of the United States Public Health Service, has been elected professor of tropical medicine in the University of Maryland.

MR. W. G. FEARNSIDES, fellow and lecturer in natural sciences at Sidney Sussex College, and demonstrator in petrology in the University of Cambridge, has been appointed to the Sorby chair of geology at Sheffield University.

DISCUSSION AND CORRESPONDENCE

NOMENCLATURE IN PALEONTOLOGY

TO THE EDITOR OF SCIENCE: I ask the courtesy of your columns to explain certain allusions in a recent contribution which seem to have been somewhat misunderstood by my good friend Dr. Peale. In criticizing a prevalent custom in vertebrate paleontology of identifying as to genus and species very fragmentary material which is not really exactly identifiable, I spoke of its having "sadly misled" him into presenting as conclusive evidence of identity in age a correspondence in fauna (*i. e.,* in the fauna as listed) that was really no evidence at all. The criticism was in no wise directed at Dr. Peale, as he seems to suppose, nor at individual vertebrate paleontologists, but at a prevalent custom in this branch of science which I think ought to be amended. Naturally, Dr. Peale is perfectly justified in depending upon the published lists (*if* they have not since been criticized or amended or new and better evidence secured); and vertebrate paleontologists are presumably justified in following the customs of their tribe. But this is a vicious custom, and the fact that it misled so eminent a stratigrapher was cited as an instance of the harm it does.

Dr. Peale finds it "interesting to have a vertebrate paleontologist make the statement that 'correspondence in fauna is not conclusive evidence of identity in age.'" Well, I am not so rash as to say that it *is,* without making a number of reservations as to adequacy, presentation and interpretation of the evidence, etc. (for certain other considerations see article in *Bull. Geol. Soc. America* for 1913, p. 283). But I did not make the statement he attributes to me, if I understand the meaning of words, and considering the context in which I was using them in the cited article. I was discussing faunal lists based upon specimens too fragmentary for exact identification. Such a "correspondence in fauna" is *not* conclusive proof of identity in age. That does not mean that vertebrate paleontology has no place in stratigraphic geology. Fossil vertebrates, provided the material is adequate and the identifications correct, afford a much more exact geological timepiece than do invertebrates or plants. But the material is always scanty and often inadequate, and the degree to which this is true must in each case be taken into consideration in interpreting their evidence. Furthermore, owing partly to the greater exactness of our timepiece, we are conscious of certain normal deviations from accuracy—if one may so speak—regional, environmental, etc., which although their effects upon the existing flora as well as fauna are obvious

enough, are not always considered by paleobotanists and stratigraphers.

It should be noted that my criticism was limited to the inference that the evidence from vertebrate paleontology as cited was conclusive in this problem. I have expressed no opinion as to the validity of Dr. Peale's conclusions in regard to the age of the Judith River fauna, chiefly because the subject is under investigation and the evidence is not all in yet. Mr. Barnum Brown has spent four or five months of nearly every year from 1899 to the present date, in collecting vertebrate and other fossils for the American Museum from the Lance, Hell Creek, Judith River, Ojo Alamo, Edmonton and Belly River beds, most of which are or have been included under the broad designation of the Laramie Group.[1] He has secured a large amount of fine material, made extensive observations on the stratigraphy, and kept accurate records of the location and level of his finds. Certain other parts of the problem are under investigation by Messrs. Granger and Sinclair in New Mexico and Wyoming. Until these data have been compared, studied and coordinated with those previously published, it seems better to retain an open mind in regard to the tenor of the evidence from fossil vertebrates on the Laramie question.

W. D. Matthew

American Museum of Natural History,
July 1, 1913

MENDELIAN FACTORS

To the Editor of Science: The alternative interpretation proposed by Dr. Henri Hus[2] for ratios found in F_2 crosses between sweet and waxy varieties of maize, suggests the question whether we are to use Mendelian factors merely as a form of notation to aid in the orderly arrangement of certain facts of heredity, or go further and insist that they have a real existence. The observed ratio of 9 horny seed, 3 waxy seed and 4 sweet seed was represented as resulting from the interaction of two factors, a factor S for sweet endosperm and a factor X for waxy endosperm. The presence of both S and X was assumed to result in horny endosperm. In the self-pollinated progeny of a sweet-waxy hybrid, both S and X would be present in 9 out of every 16 seeds and this was the number of horny seeds observed. X alone would occur in 3 out of 16, the ratio in which the waxy seeds occurred. S would also occur alone in 3 out of 16 seeds, but the number of sweet seed was found to be 4 instead of 3 out of 16. On this hypothesis, therefore, the one seed out of every 16 which would have neither X nor S was included with the sweet seeds.

Dr. Hus's proposed changes are in effect to substitute W for our X, H for our S, and to add a common factor called S to all the members involved.

To the writer the only object in premising factors at all is that by their use predictions are made possible, and in the present case two factors are adequate for this purpose. To assume a third factor is like adding an unknown constant to both sides of an equation.

The test proposed by Dr. Hus for the reality of the H factor is the same as one of the tests originally outlined as a test for the same factor which we called S. What is needed to prove the superiority of the formula proposed by Dr. Hus is some method of testing the reality of the common basic factor. Until some plant is discovered in which the basic character is absent there appears to be no way of doing this. The presence of a factor can neither be demonstrated nor disproven so long as it is assumed to be universally present.

When sweet and horny were the only alternative kinds of endosperm known the presence and absence of a single factor was adequate to make predictions regarding their behavior. With the discovery of waxy endosperm it was necessary to add a second symbol. But until another form comes to light it is difficult to understand how a third symbol helps us to an understanding of the inheritance of these characters.

If the symbols are taken to represent actual entities it is of course anomalous to have a

[1] Not in the Laramie *formation* as now limited by the U. S. Geological Survey.

[2] Science, June 20, 1913, p. 940.

character represented by the absence of all factors. But in avoiding this anomaly, calculation is made more difficult and the only object gained is to lend an unwarranted appearance of reality to what is merely a convenient formula for expressing the observed relations.

G. N. COLLINS

WASHINGTON, D. C.,
June 30, 1913

SWEDENBORG

TO THE EDITOR OF SCIENCE: At the top of the second column of page 100 of SCIENCE for January 17, 1913, I note the following statement by one of your correspondents: "But Swedenborg would be laughed out of a modern court of science."

I find in a brief Life of Swedenborg, by J. Stuart Bogg (Frederick Warne & Co., London and New York, 1911), that Swedenborg was a wide traveler, a friend of learned men, a student of astronomy, metallurgy and anatomy, an inventor, a practical-minded, useful member of the Swedish House of Nobles, assessor in the Royal College of Mines and an author of numerous scientific works. Among his inventions were a plan for a submarine boat and a plan for a flying machine based on the now known principles of heavier-than-air machines. He declared that a very slight force would be sufficient to keep such machines up, but he knew nothing, of course, of gasoline motors. In the domain of astronomy he originated a method for finding terrestrial longitude by means of the moon. In the House of Nobles he took an active interest in such matters as the finances of the country, the liquor traffic and the mines. Among his scientific publications were works on chemistry, metallurgy, astronomical methods, observations connected with the physical sciences, and the economy of the animal kingdom. Until he was fifty-five years of age he was wholly occupied in these scientific and practical pursuits and was respected by scholars and patrons of learning at home and abroad.

In a prospectus which lies before me of a new edition of Emanuel Swedenborg's Scientific Works, I see that "Swedenborg's discoveries and theories in various departments of science have awakened an increasing interest among specialists during the past century," that they led the Royal Swedish Academy of Sciences to appoint a Swedenborg committee in 1902, and that this academy had in 1907 already published Vol. I. of the new edition in the original Latin and Swedish.

In view of these facts it seems strange to me that any one should affirm that "Swedenborg would be laughed out of a modern court of science." Is it possible that those who would laugh him out have never read his scientific works at all? If so, perhaps they could profitably reflect on the following quotation from Herbert Spencer:

> There is a principle which is a bar against all information, which is proof against all argument, and which can not fail to keep a man in everlasting ignorance; this principle is contempt prior to examination.

ANDREW H. WARD

A NEW VARIETY OF JUGLANS CALIFORNICA WATSON

THERE recently appeared in these columns a brief note by N. B. Pierce entitled "A New Walnut." It included a very brief general description which could not be accepted as a diagnosis in the usual meaning of that term. Yet Dr. Pierce stated that he thought it desirable to give the new form a name at that time and that he intended to publish a full description later. But Dr. Pierce did not see fit to cite the diagnostic description of this form which was published (but without reference to a scientific name) in Jepson's "Silva of California."[1] Had he done so the name he proposed would stand, even though unsatisfactory to one who has studied the form carefully.

However, I take it that *Juglans quercifolia* Pierce is a *nomen nudum* and that it still remains to publish a scientific name and diagnosis *together*. Therefore, I take pleasure in recording the same as follows:

New Variety: Juglans californica var. *quercina*. Diagnosis by the undersigned in

[1] Jepson, W. L., "Silva of California," Univ. Calif. Memoirs, Vol. II., 1910, p. 54.

Jepson's "Silva of California,"[2] the same to be reprinted under the above name in University of California Publications, Agricultural Science Series, Vol. II., No. 1 (now in press).

The chief reason for describing this form as a variety rather than a species is that *it does not breed true.* Several tests of seeds from different trees of this form have been made by the writer and in all but one test a number of the seedlings (never the same proportion) are typical *J. californica* in leaf characters. Obviously this is sufficient proof of a relationship which it is highly desirable to indicate by the name employed.

The reason for rejecting the name *quercifolia* is that the leaves are *not* oak-like. They resemble leaves of certain species of *Rhus* more than oaks. For this reason the writer had considered *anacardifolia* as a name, but the leaves are very unlike those of some species of the Anacardiaceæ. On the other hand, in general appearance of the trees this walnut does resemble a small-leaved oak. This is largely due to the habit of growth, the small size of the leaves and the dark green color of the foliage. Hence the name *quercina* is deemed proper, especially when used in varietal rank.

E. B. Babcock

[2] *Ibid.*

SCIENTIFIC BOOKS

Principia Mathematica. By Alfred North Whitehead, Sc.D., F.R.S., Fellow and late Lecturer of Trinity College, Cambridge, and Bertrand Russell, M.A., F.R.S., Lecturer and late Fellow of Trinity College, Cambridge. Cambridge University Press. 1912. Vol. II. Pp. xviii + 772.

Differential and Integral Calculus. An Introductory Course for Colleges and Engineering Schools. By Lorrain S. Hulburt, Collegiate Professor of Mathematics in the Johns Hopkins University. New York, Longmans, Green and Co. 1912. Pp. xviii + 481.

An Elementary Treatise on Calculus. A Textbook for Colleges and Technical Schools. By William S. Franklin, Barry MacNutt and Rollin L. Charles, of Lehigh University. Published by the authors. South Bethlehem, Pa. 1913. Pp. vi + 292.

The Calculus. By Ellery W. Davis, Professor of Mathematics, the University of Nebraska, assisted by William C. Brenke, Associate Professor of Mathematics, the University of Nebraska. Edited by Earl Raymond Hedrick. New York, The Macmillan Company. 1912. Pp. xx + 446.

Readers who desire to gain with a minimum of effort a fair knowledge of the nature, magnitude, method and spirit of Messrs. Whitehead and Russell's great undertaking and achievement may be referred to the *Bulletin of the American Mathematical Society,* Vol. XVIII., and to Science for January 19, 1912, where will be found somewhat extensive reviews of Vol. I. of the "Principia." The immensity of Vol. II., together with its exceedingly technical content and method, make it undesirable to review this volume minutely in this journal, and the purpose of this notice is merely to signalize the appearance of the work and to indicate roughly the character and scope of its content.

Owing to the vast number, the great variety and the mechanical delicacy of the symbols employed, errors of type are not entirely avoidable and the volume opens with a rather long list of "errata to Volume I." The volume in hand is composed of three grand divisions: Part III., which deals with cardinal arithmetic; Part IV., which is devoted to what is called relation-arithmetic; and Part V., which treats of series. The theory of types, which is presented in Vol. I., is very important in the arithmetic of cardinals, especially in the matter of existence-theorems, and for the convenience of the reader Part III. is prefaced with explanations of how this theory applies to the matter in hand. In the initial section of this part we find the definition and logical properties of cardinal numbers, the definition of cardinal number being the one that is due to Frege, namely, the cardinal number of a class C is the class of all classes similar to C, where by "similar" is meant that two classes are similar when and only when the elements

of either can be associated in a one-to-one way with the elements of the other. This section consists of seven chapters dealing respectively with elementary properties of cardinals; 0 and 1 and 2; cardinals of assigned types; homogeneous cardinals; ascending cardinals; descending cardinals; and cardinals of relational types. Then follows a section treating of addition, multiplication and exponentiation, where the logical muse handles such themes as the arithmetical sum of two classes and of two cardinals; double similarity; the arithmetical sum of a class of classes; the arithmetical product of two classes and of two cardinals; next, of a class of classes; multiplicative classes and arithmetical classes; exponentiation; greater and less. Thus no less than 186 large symbolically compacted pages deal with properties *common* to finite and infinite classes and to the corresponding numbers. Nevertheless finites and infinites do differ in many important respects, and as many as 116 pages are required to present such differences under such captions as arithmetical substitution and uniform formal numbers; subtraction; inductive cardinals; intervals; progressions; Aleph null, $\aleph_0$; reflexive classes and cardinals; the axiom of infinity; and typically indefinite inductive cardinals.

As indicating the fundamental character of the "Principia" it is noteworthy that the arithmetic of relations is not begun earlier than page 301 of the second huge volume. In this division the subject of thought is relations including relations between relations. If R_1 and R_2 are two relations and if F_1 and F_2 are their respective fields (composed of the things between which the relations subsist), it may happen that F_1 and F_2 can be so correlated that, if any two terms of F_1 have the relation R_1, their correlates in F_2 have the relation R_2, and *vice versa.* If such is the case, R_1 and R_2 are said to be *like* or to be *ordinally similar.* Likeness of relations is analogous to similarity of classes, and, as cardinal number of classes is defined by means of class similarity, so relation-number of relations is defined by means of relation likeness. And 209 pages are devoted to the fundamentals of relation-arithmetic, the chief headings of the treatment being ordinal similarity and relation-numbers; internal transformation of a relation; ordinal similarity; definition and elementary properties of relation-numbers; the relation-numbers, 0_r, 2_r and 1_s; relation-numbers of assigned types; homogeneous relation-numbers; addition of relations and the product of two relations; the sum of two relations; addition of a term to a relation; the sum of the relations of a field; relations of mutually exclusive relations; double likeness; relations of relations of couples; the product of two relations; the multiplication and exponentiation of relations; and so on.

The last 259 pages of the volume deal with series. A large initial section is concerned with such properties as are common to all series whatsoever. From this exceedingly high and tenuous atmosphere, the reader is conducted to the level of sections, segments, stretches and derivatives of series. The volume closes with 58 pages devoted to convergence, and the limits of functions.

To judge the "Principia," as some are wont to do, as an attempt to furnish methods for developing existing branches of mathematics, is manifestly unfair; for it is no such attempt. It is an attempt to show that the entire body of mathematical doctrine is deducible from a small number of assumed ideas and propositions. As such it is a most important contribution to the theory of the unity of mathematics and of the compendence of knowledge in general. As a work of constructive criticism it has never been surpassed. To every one and especially to philosophers and men of natural science, it is an amazing revelation of how the familiar terms with which they deal plunge their roots far into the darkness beneath the surface of common sense. It is a noble monument to the critical spirit of science and to the idealism of our time.

Of the making of many text-books of the calculus there is no end. The phenomenon is doubtless due to a variety of causes, literary, economical, scientific and educational. Chief among the causes is the felt desirability of producing text-books of mathematics that will

work the miracle of pleasing at once mathematicians who are not engineers and engineers who are not mathematicians.

Perhaps the most notable feature of Professor Hulburt's book is the excellence of its English. No doubt mathematical truth is like other scientific truth in the characteristic respect that its significance does not depend primarily upon the form in which it is expressed. It ought not to be forgotten, however, that its accessibility does depend upon its form. A loose definition of a mathematical term is not a mathematical definition. A vague statement of a proposition is not a statement of a mathematical proposition. Discourse that is not precise, cogent and concatenative is not mathematical discourse. For some unexplained cause departments of English fail to give their pupils such facility in English expression as is available for mathematical purposes. And those whose fortune it is to teach undergraduate mathematics find it necessary in classroom to devote half their time and energy to trying to secure on the part of their pupils decent, I do not say elegant or imposing or fine, but merely decent expression of ideas. In this important matter, an excellent model is of very great assistance, and such a model Professor Hulbert has furnished. Most excellence is excellence of emphasis. In this respect, too, the book is a model; doctrines are presented in perspective. The nature of the differential and the utility of the differential notation are made perfectly, unmistakably, intelligible—something that unfortunately can not be said of some current presentations. As to the order of themes, there may be difference of judgment. Integration is introduced on page 175. Practise in integrating is recommended and afforded before the use of tables, given at page 190. Teachers will value the introduction to analytical geometry of three dimensions, page 265. Taylor's series is presented as late as page 349. The work closes with an excellent account of simple differential equations, and a list of answers to exercises distributed throughout the volume. Printing and binding are well done and the page pleases the eye.

In the composition of their interesting work, Messrs. Franklin, MacNutt and Charles have been guided by certain convictions. For example, they believe that "to break the thread of the textual discussion by unnecessary algebraic developments and by large and frequent groups of purely formal problems," as is commonly done, is a "really hideous feature"; and they have sought to avoid such a blemish by relegating the majority of the formal problems to an appendix. This plan has not prevented them, however, from introducing a plenty of exercises into the body of the text. Again, they are convinced that, very unfortunately, nearly all scientific text-books carry the "false suggestion of completeness and finality," and, accordingly, in order to guard the reader against gaining such an impression from their book, the authors have very laudably given in an appendix "a carefully selected list of treatises on mathematics and on mathematical physics." The book is notable for the pains the writers have taken to keep the science of the calculus attached to reality, and everywhere throughout the work one detects the odor of physical science. On this account, perhaps, theoretical developments seem to have suffered in comparison, sometimes even consciously, as in case of the notions of infinitesimal, differential, divergence and curl. Indeed the authors characterize the articles dealing with these ideas as "fallacious," "mere plausibilities," and as being such that "the harder one tries to understand them the more vague and unintelligible they become." We are disposed to think that the authors, if not too modest and frank, have overrated the difficulty of presenting the matters in question soundly and clearly. The final chapter, 43 pages, is devoted to an elementary exposition of vector analysis, an element of the book that many will gladly welcome.

Professors Davis, Brenke and Hedrick have produced a very teachable book. It would be more pleasing if the print were larger and the pages less crowded. In an unusual degree one finds here the spirit of the calculus. Designed equally for the college and the engineering

school, the volume is rich alike in fine theoretical considerations and in varied applications. Theory, however, is not overdone and the applications are chosen with unusual regard to their intelligibility.

C. J. KEYSER

COLUMBIA UNIVERSITY

Instinct and Experience. By C. LLOYD MORGAN, Professor in the University of Bristol. New York, The Macmillan Company. 1912. Pp. xvii + 299.

"Once more I urge that the more clearly we distinguish the scientific problems from the metaphysical problems the better it will be both for science and for metaphysics" (p. 292). This, the concluding sentence of Professor Morgan's book, suggests the tenor of his discussion.

The volume is the direct outcome of a symposium on instinct and intelligence which was held in London in the summer of 1910. The several papers contributed to the symposium were published in the *British Journal of Psychology,* Vol. 3, 1909–10. Professor Morgan's views concerning instinct and intelligence differed in many respects from those of certain of the other speakers, and in the present work he has, at some length, presented and defended them in contrast with those of Messrs. Myers, McDougall and Stout.

Although the author would doubtless resent the suggestion, the reviewer looks upon this work as philosophical rather than purely scientific in nature. It deals largely with definitions, relations, speculations and presuppositions, and with attempts to draw a line between the naturalistic and the metaphysical disciplines. This is undoubtedly a profitable task from Professor Morgan's standpoint, but from the reviewer's it is decidedly less profitable than attempts to supply the deficiencies in our knowledge of instinct and intelligence.

And yet Professor Morgan insists, even in his opening paragraph, "My aim is to treat the phenomena of conscious existence as a naturalist treats the phenomena of organic life. I shall therefore begin with instinctive behavior and shall endeavor to give some account of the nature of the instinctive experience which, as I believe, accompanies it. In this way we shall get some idea of what I conceive to be the beginnings of experience in the individual organism" (p. 1). From this statement, one might suppose that the book would be devoted chiefly to the phenomena of instinctive and intelligent behavior, rather than to a consideration of the relations of instinct and experience or of the necessity of avoiding metaphysical problems.

Resting his contention upon the physiological discoveries of Sherrington and his coworkers, Professor Morgan insists that we must, in the end, distinguish instinctive from intelligent activities by describing the changes which occur in the central nervous system. The instinctive is dependent upon subcortical processes; and the intelligent, by contrast, is dependent upon cortical processes.

Throughout the book, but especially in Chapters II., The Relation of Instinct to Experience, III., Reflex Action and Instinct, and IV., Hereditary Dispositions and Innate Mental Tendencies, the importance of studying the functions of the central nervous system in their relations to different forms of activity is emphasized.

Effective consciousness, by which the author means consciousness that has something to do with the form of behavior, is supposed to be "connected with the process of profiting by experience" and to be "correlated with" the functions of the cerebral cortex. There is every reason, the author contends, to attempt to write a natural history of effective consciousness, a natural history of experience "as it somehow actually runs its course."

Concerning the doctrine of epiphenomenalism, the author observes that we have no proof whatever that the same brain processes which occur in connection with intelligent activity, accompanied by consciousness, ever occur in precisely the same way when these accompaniments are lacking. Professor Morgan does not believe that behavior would remain the same if the cerebral processes occurred without "correlated intelligence" (p. 262).

At the very beginning of life, inherited mechanisms are set going by appropriate situations. The reaction complex is instinctive. But immediately, if the organism possesses a cortical mechanism, profiting by reaction commences and each new performance, each new response to a given situation, in some measure modifies the creature, and by adding to its sum of experience, renders it more intelligent. Professor Morgan does not seriously discuss the question of whether intelligence or experience may exist in organsms which do not possess a cerebral cortex.

The author's conception of the relation between instinct and emotion is thus stated: "When a specific situation affords an appropriate constellation of stimuli, there issue reflexly from the subcortical centers two sets of efferent impulses, (1) those which evoke a specific mode of instinctive behavior, including those motor responses which constitute much of the so-called emotional expression; (2) those which evoke visceral disturbance—changes of heart-beat, and of the respiratory rhythm, modifications of the digestive and glandular functions, alterations in the peripheral vascular flow, a diffused influence on the general cœnæsthesis and so forth. From all this complex of bodily changes under (1) and (2) afferent impulses come into the central nervous system, and, when they reach the cortex, qualify the experience of the presented situation and thus complete the instinctive experience with its accompanying emotional tone. I regard it as probable that, in its primary genesis, the emotional tone is in large measure correlated with the cortical disturbance due to stimulation which is visceral and cœnæsthetic in origin" (p. 112).

In the final chapters of the book, VII., The Philosophy of Instinct, and VIII., Finalism and Mechanism: Body and Mind, Professor Morgan offers a critique of the views of Mr. Bergson, together with comments on those of Messrs. Myers, McDougall and Driesch.

The book is clearly and persuasively written and will undoubtedly prove agreeably profitable to readers who approach it as a general philosophical discussion of the subject, rather than as a contribution to the science of behavior. The reviewer's sole objection to the discussion is that it meets no urgent need.

R. M. Yerkes

Glycosuria and Allied Conditions. By P. J. Cammidge, M.D.

The increase which has occurred within the past decade or so in the number of cases of glycosuria—an increase which is only in part due to refinements of diagnosis—is demanding the attention of a large number of investigators as to the causes which give rise to this condition.

Although the milder degrees of glycosuria are not associated with the other well-known symptoms of diabetes, yet the latter are liable gradually to develop unless great care and judgment be used in controlling the diet of the patient. To do this efficiently the physician must familiarize himself with the more strictly scientific work bearing on the history of carbohydrates in the animal body, and it comes to be of importance that for this purpose he should be able to procure reliable and up-to-date reviews of the work that has been done.

In the present volume, from the pen of a clinical worker, a praiseworthy account is offered of much of the recent work—both clinical and experimental—bearing on the causes and treatment of various degrees of glycosuria. It is, however, more particularly with the part of the book bearing on the purely scientific aspect of the problem that the present review is concerned.

In the first chapter the general chemical properties and relationships of the various carbohydrates are sufficiently explained for most purposes, greater details being offered in the form of an appendix. Too little attention is, however, given to the condition of carbohydrates in the blood, an omission which, in view of the large amount of recent important investigation, is rather disappointing. The statement on page 17 that the blood is of definite alkalinity is hardly in keeping with modern teaching.

The two chapters which follow are devoted to a description of the different processes used in the detection and estimation of the various sugars in urine. There is much unnecessary detail regarding methods that are practically obsolete and the reader is not sufficiently informed as to which of those described the author, from personal experience, would recommend him to employ. The use of charcoal for the clarification of turbid urine (for polariscope examination) is condemned, because of adsorption of some of the sugar (p. 98), but no mention is made of the prevention of this adsorption when acetone or acetic acid is present in the solution. The method described for the estimation of the sugar in blood is obsolete.

In the chapter entitled "Experimental Glycosuria" a clear and well-arranged account of the results of some of the more recent laboratory investigations on this subject is given. The author, probably because he has not personally participated in such types of investigation, does not attempt to offer much criticism of the work; as a rule, he merely restates the views of others, thus leaving the reader to draw his own conclusions. In several parts of this chapter, however, the subject matter is not brought up to date as, for instance, in connection with the supposed antagonistic action of the pancreatic and adrenal glands in the control of the amount of sugar in the blood. The paragraphs on the relationship of the thyroid and parathyroid glands to carbohydrate metabolism and "on a theory of the co-relation of the ductless glands" are one-sided and highly speculative.

The remaining chapters are devoted to a study of the various degrees of transient and persistent glycosuria met with in man. This is distinctly the most important half of the book, for, while giving a well-arranged review of the work of other investigators, important personal experiences of the author himself are presented. Although it would be out of place for us to review at all extensively, this clinical portion of the book, there are yet one or two criticisms which may be appropriate. The account of the behavior of the creatin-creatinin excretion in diabetes is not brought up to date; there is practically no mention of the recent observations on the changes in the amount of the blood-sugar in diabetes; the so-called pancreatic reaction in the urine is not described in sufficient detail to make it possible for one unfamiliar with the author's previous writings to apply it properly, or even to understand upon what principles the reaction depends. The author lays great stress on the existence of pancreatic disease in most cases of diabetes, but beyond giving the case histories of a few diabetics in which pancreatic lesions may have existed, he adds no further evidence in support of such a conclusion.

The chapters on metabolism and treatment are distinctly successful and should be most useful to those called upon to treat this disease.

Taking the book as a whole it is not too much to say that it ranks with the best that have been written in this field. It is conservative and does not, as many of its forerunners do, extol any "specific" treatment which can be applied in all cases. On the contrary, it is frequently insisted upon that every case of diabetes must be considered as a problem in itself, and that the treatment must be adjusted so as to meet the peculiar conditions which it exhibits.

J. J. R. MACLEOD

WESTERN RESERVE MEDICAL COLLEGE

SPECIAL ARTICLES

THE PREVALENCE OF BACILLUS RADICICOLA IN SOIL

THE fact that soils from fields where leguminous plants bear nodules upon their roots may be used as a means of introducing this type of nitrogen-fixing bacteria into barren soil shows clearly that the different varieties of *Bacillus radicicola,* the organism which causes the root nodules, find a congenial habitat in many kinds of soil. Aside from its manifestations in the symbiotic relationship with leguminous roots, however, practically nothing is known regarding the distribution

or function of *B. radicicola* as it occurs in nature. Within the past three years two authors, employing widely different methods, have attempted to supplement this rather meager information. With a rather comprehensive plan for tracing the functional activity presumably of nodule-forming bacteria from the soil, through pure culture conditions, and into root nodules again Gage[1] apparently confused himself with a variety of seemingly incompatible results, and by his unusual selection of descriptive terms heightened the indefinite character of his report; but even if his conclusions were absolutely correct no real advance has been made in our knowledge of the life history of *B. radicicola.*

A synthetic medium has been developed by Grieg-Smith,[2] who states that it is almost specifically selective for *Rhizobia.* It should be noted that *Rhizobia* is not defensible as a generic designation for *Bacillus radicicola.*[3] If the selective phenomenon of this culture medium were consistent for wide variations of soil flora and soil type, we should have in this medium a means for determining the approximate numbers of *B. radicicola* in any soil and their relation to other members of the microflora of the soil. The agar medium as described contains levulose, asparagine, sodium citrate, potassium citrate and tap water. At the time of using from 0.06 to 0.10 cubic centimeters of normal sodium carbonate is added to 10 cubic centimeters of the agar.

Plates of a medium prepared by these criteria were exposed to the air in the laboratory at Washington for 15 minutes. An average of four species of molds to the plate developed; also numerous species of bacteria, some of which were chromogenic. In order to compare the growth of molds in other media, there were exposed in various places in the laboratory petri plates containing beef agar, the nitrogen-free agar developed by us for isolating *B. radicicola,*[4] and Grieg-Smith's agar made with and without the addition of sodium carbonate. Table I. shows the results of these tests.

TABLE I

Number of Species of Molds Developing upon Various Media[5]

Beef Agar	Nitrogen-free Agar	Grieg-Smith Agar	Grieg-Smith Agar + Sodium Carbonate
1	3	5	4
3	2	2	2
—	1	3	2
2	3	4	4

Further tests were made by inoculating various cultures of bacteria into Grieg-Smith's agar, with the sodium carbonate added. Tubes of slanted agar were used and the organisms were streaked over the surface. The following organisms grew:

Sulphur yellow bacillus,
Bacillus coli,
Bacillus cloaca,
Micrococcus roseus,
Bacillus rossica,
Bacillus prodigiosus,
Staphylococcus aureus,
Bacillus mycoides,
Azotobacter beyerinckii (on petri dish),
Azotobacter chroococcum (on petri dish).

The following organisms did not grow:

Bacillus subtilis, black variety,
Bacillus radicicola isolated from vetch nodules,
Bacillus radicicola isolated from *Ceanothus* nodules,
Bacillus radicicola isolated from *Cycas* nodules,
Bacillus radicicola isolated from lima-bean nodules,
Bacillus radicicola isolated from alfalfa nodules.

[1] Gage, G. E., "Biological and Chemical Studies on Nitroso Bacteria," *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten,* 2. Abt., Bd. 27, No. 1/3, pp. 7–48, 1910.

[2] Grieg-Smith, R., "Determination of *Rhizobia* in the Soil," *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten,* 2. Abt., Bd. 34, No. 8/9, pp. 227–229, 1912.

[3] Kellerman, Karl F., "The Present Status of Soil Inoculation," *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten,* 2. Abt., Bd. 34, No. 1/4, pp. 42–50, 1912.

[4] Tap water, 1,000 c.c.; cane sugar, 10 grams; monobasic potassium phosphate, 1 gram; magnesium sulphate, 0.2 gram; shredded agar, 15 grams, with reaction adjusted to + 4 Fuller scale.

[5] Petri dishes opened for 15 minutes in the laboratory rooms at different times during the day. The figures are the averages of two plates for each exposure.

The growth of pure cultures of *B. radicicola* on this medium was further tested by the usual methods of poured plates in petri dishes. The relative suitability of the different media is shown in Tables II. and III.

TABLE II

Growth of B. radicicola in Grieg-Smith's Synthetic Media

Source	Strain	Media	
		Grieg-Smith's Agar	Grieg-Smith's Agar + Sodium Carbonate
Alfalfa............	No. 101	+	+
Alfalfa............	No. 134	—	—
Alfalfa............	N. Y. soil[6]	+	+
Alfalfa............	D. C. soil[7]	—	—
Cowpea............	No. 103	+	+
Crimson clover...	No. 156	+	+

TABLE III

Comparative Suitability of Different Media for the Growth of B. radicicola

Source	Strain	Grieg-Smith Agar	Grieg-Smith Agar + Sodium Carbonate	Nitrogen-free Agar
Alfalfa....	No. 153	—	+	+
Alfalfa....	No. 134	—	+	+
Vetch......	No. 151	—	—	+

Following the technique outlined by Grieg-Smith, direct isolation of *B. radicicola* was attempted from soil of three types: (1) soil used in potting plants at the Department of Agriculture greenhouses; (2) soil from Akron, Colo., taken from around the roots of *Astragalus falcatus* Lam., and known by check experiments to be able to inoculate the roots of *Astragalus sinicus* Linn.; and (3) soil from Ithaca, N. Y., which had been sterilized and inoculated with *B. radicicola* isolated from alfalfa nodules. The ordinary dilution technique was employed and dilutions of 1:100, 1:10,000 and 1:1,000,000 were taken. The agar was used with and without sodium carbonate, and the plates incubated five or six days at room temperature.

[6] This test was made with New York soil furnished by Dr. B. M. Duggar, which he sterilized and then inoculated with a strain of bacteria isolated at Cornell University from alfalfa nodules.

[7] This test was made with District of Columbia soil which was sterilized and then inoculated with alfalfa bacteria, strain No. 134.

The greenhouse soil developed molds and various kinds of nonchromogenic bacteria on both media; on the media with sodium carbonate the Colorado soil developed molds and various kinds of nonchromogenic bacteria, while the media without the sodium carbonate gave an almost pure culture of one species; the New York soil gave pure plates with both agars. In observing these plates it was very noticeable that the agar with the sodium carbonate showed fewer colonies than the agar without it; this has been noticed in regard to both pure and mixed cultures.

The colonies selected for final test were those which resembled pure cultures of *B. radicicola.* The bacteria isolated from New York soil and from greenhouse soil were tested for their ability to infect alfalfa, and those from the Colorado soil were tested for their ability to infect *Astragalus sinicus.* These selections for tests were made because of previous empirical determinations of the inoculating power of these soils.

The tests were conducted in sand nearly devoid of nitrogen, moistened with Sach's solution from which the nitrogen compounds were lacking. Special glass jars designed to prevent contamination were employed for sheltering the plants which were grown from disinfected seeds. The plants grew well, considering the abnormal conditions to which they were subjected. At the expiration of 63 days the plants were taken from the jars and the roots carefully washed. Table IV. shows the inoculating power of the colonies selected from the petri plates of Grieg-Smith agar.

TABLE IV

Inoculating Power of Bacteria from Various Soils Isolated upon Grieg-Smith Agar

Plant	Source	Inoculation
Alfalfa	New York soil	+
Alfalfa	Greenhouse soil	—
Alfalfa	Uninoculated	—
Astragalus sinicus ..	Colorado soil	—
Astragalus sinicus ..	Uninoculated	Plants died.

Since the New York soil contained only living organisms of *B. radicicola* known to be capable of inoculating alfalfa, the inoculation of alfalfa by the organism isolated from the New York soil was to be expected.

It seems fair to conclude that *B. radicicola* grows but sparingly and shows no especial characteristics upon synthetic agar made in accordance with the formula reported by Grieg-Smith, which seems to be no more selective than the synthetic agar we have employed for many years in the Washington laboratories, and is perhaps less selective than the congo-red agar described by one of us.[8] Further development of technique or of culture media will be required before we may hope to secure reliable data regarding the relative distribution and quantitative function of *B. radicicola* in the soil.

Karl F. Kellerman
L. T. Leonard

Bureau of Plant Industry,
Washington, D. C.

SOME EFFECTS OF SUNLIGHT ON THE STARFISH

Starfish have been much studied for their reactions to light. Their general reactions and behavior have been well described by Preyer, von Uexkull, Jennings and others, and there is general agreement in the results recorded by these writers. Details of behavior of the different parts affected by light are for the most part meager or omitted.

The general reactions of *Asterias forbesii* are essentially like those described for other starfish and there is no reason to suppose that its reactions are essentially different in detail so far as it is possible to observe them. It has been previously shown by the writer[1] that certain parts of the animal are sensitive to light. It has further been found that there is a definite time reaction between the moment when the light strikes the sensitive parts and the moment when they show a definite visible response, and the general reaction which follows, provided the light has sufficient intensity.

Individuals without the pigment or "eye" spots react as definitely to light as do those with the pigment spots intact. This was also found to be true for *Echinaster* (Cowles). The upper surface, the sides of the rays, the ventral surface and the tube feet are sensitive to light, since they show a direct response to it. The dermal branchia also show response to light stimuli. The behavior of dermal branchia is of peculiar interest, since their retraction must influence the extent of the aerating surface of the animal. The sudden illumination of a ray or a spot on it causes a retraction of the parts illuminated. If the area is large there is a bending of the ray ventralward no matter what the direction of the source of light. Following this primary reflex, there arise movements which lead eventually to the general response or behavior. Three stages are recognizable. These are: the initial or direct effect of light; the local direct response of the parts affected, and lastly the general effect and reactions in response to the influence of the preceding changes. It is apparently through these interactions that the external stimulus is finally transformed into reaction and behavior through the vortex of metabolic changes in protoplasm.

Loeb has maintained that "reactions are caused by a chemical effect of light" and that "the velocity or the character of the chemical reactions in the photosensitive elements of both sides of the body is different," and hence "the muscles or the contractile elements on one side of the organism are in a higher state of tension than their antagonists." One wishes for more direct evidence and, if such is possible, direct proof that light does influence the chemical processes of normal metabolism, than the above assumptions afford. While it is generally assumed that light does cause chemical changes in organisms and these must influence the reactions of the organisms, there is a significant absence of direct experimental proof.

[8] Kellerman, Karl F., "The Relation of Crown-gall to Legume Inoculation," U. S. Department of Agriculture, Bureau of Plant Industry, Circular 76, p. 4, 1911.

[1] Science, N. S., Vol. 35, p. 119.

Jennings sought an explanation of behavior based on physiological grounds and concluded that since the organism may react differently under apparently similar conditions, reactions are due to differences in physiological states. He cites instances in which the physiological conditions, such as hunger, for example, are known to modify reactions.

Mast (1911, page 369) admits that the "belief that light in some way influences the activity of organisms by chemical changes which it causes in them" is founded on hypothetical assumptions. Any direct evidence either in agreement with or opposed to these views, although it may need further verification, would be of importance.

It must be remembered that little is positively known concerning the character of chemical changes in metabolic processes. It is true, however, that of the various physiological states, or conditions which might effect them, the maintenance of the neutral or slightly alkaline condition in an organism is of the greatest importance, and this condition is not easily changed. Any change in this state it should be possible to detect provided a proper means be found. It is assumed that the organization of protoplasm involves and demands physical-chemical relations and changes of a progressive kind, with some range of disturbance possible without causing complete disorganization or breaking down of the chain of changes. These changes must be maintained within the limits of the conditions which make possible their continued recurrence. This has aptly been likened to a "vortex."

The natural result of a stimulus breaking in upon these regular changes may be to stop some, accelerate others, divert others into combinations different from those which would normally occur. That the stimulus (light) would cause a chemical change which would be the cause of the reaction is limiting the possibilities. From the viewpoint of the physiological processes it becomes a matter of importance to discover the nature of these disturbances. As previously stated, an acid or alkaline condition is of primary significance, the right condition being maintained through the interaction of certain basic and acid substances present. If it is not possible to detect these conditions directly it might still be possible to discover variations in the amount of elimination of products or alteration in their character. Accordingly, an attempt was made to discover any possible difference in these conditions.

To test for differences in respiration in the starfish two methods were used. In one series of experiments an indicator for carbon dioxide was introduced into the given amount of sea water with the specimen to be tested. Parallel experiments, one in the shade and one in the sunlight and one control, were compared. In a second series specimens were exposed in the shade and the sunlight in equal amounts of tested sea water, the sea water then after equal intervals of time being again tested.

Having made use of neutral red in class observation on the reaction of protoplasm and vacuoles in *Paramœcia,* this was tried in the starfish. Furthermore, neutral red might also show differences in *intra vitam* staining in light and shade. Dilute solutions of neutral red were made in sea water which is normally slightly alkaline in reaction, from 1:10,000 to 1:60,000. A more dilute solution was used in some cases. Given amounts, 200 c.c. to 400 c.c. of the same solution were placed in each of three large clean finger-bowls. One of these was kept for control. Two starfish equal in weight and as nearly alike as it is possible to select, which were found to react normally to light were placed one in each of the other two vessels. One of these vessels was then placed in the sunlight and the other in the shade. Both vessels were placed in a shallow aquarium of fresh sea water in order to maintain equality of temperature 18° centigrade. At intervals of two or five minutes a careful comparison was made to note possible changes in activity and degree of staining shown by each specimen. In practically every experiment at the end of five minutes, solutions and specimens showed distinct differences. In the vessel in the shade the solution showed a characteristic acid reaction, while at the same time

the one in the sunlight showed a very distinctly less amount of change, but when compared with the control it gave evidence of change. The specimen in the shade was usually more distinctly stained by the neutral red than the specimen in the sunlight, and the solution in the shade was apparently clear after the lapse of fifteen to thirty minutes, while that in the sunlight still distinctly showed the stain in solution. As might be expected in some of the experiments, the differences were more distinct than in others. It is taken that the acid reaction is due to the elimination of carbon dioxide.

A toxic effect was also evident in the experiments in the sunlight due probably to the action of the basic elements of the dye. What this is still remains to be determined. It is apparently due to effect of sunlight on protoplasm influencing metabolism in such a manner that the injurious changes occur; or it may be the effect of sunlight on the interaction of the basic dye and protoplasm or its metabolic products. A similar effect is seen in experiments with *Paramœcia*. In the sunlight there is a greater concentration of the hydroxyl ions which would give an alkaline reaction. The outcome is that hydrolysis takes place which interferes with the normal processes and produces injury to the protoplasm. In the shade the hydrogen ions have a greater concentration with the more acid reaction.

As a check upon these results a second set of experiments was made in which the reaction of the sea water was tested in which the specimens were placed without the presence of the indicator. In this series equal quantities of sea water, after being tested with the most accurate apparatus, were placed with carefully selected individuals in clean glass vessels and arranged, as in the former series, in the sun and in the shade. In this series it was possible to use the same specimen for the test at different times after exposure for equal intervals of time in the sun and in the shade. The results agreed as closely as could be expected with those in the former series.

In testing the sea water in each case an N/10 solution of hydrochloric acid and an N/10 solution of sodium hydroxide, and phenolphtalein were used. It was found in a series of ten parallel experiments that at equal intervals of time after the lapse of about five minutes from the beginning of each experiment up to fifteen minutes, the sea water from the vessels in the sunlight showed less acid reaction than that taken from those in the shade. In four cases the sea water with the specimens in the sunlight remained slightly alkaline, but less so than the normal sea water; four showed a slightly acid reaction, the two remaining were neutral. Of the parallel series in the shade at the same intervals of time, seven showed an acid reaction, two were neutral and one was very slightly alkaline. Normal sea water is alkaline. It thus appears that the metabolic processes of protoplasm under these different conditions of illumination differ to a degree sufficient to affect the sea water through differences in elimination of the products of metabolism. It is to be remembered that ten or fifteen minutes is usually sufficient for continuous sunshine to cause a starfish to take up a characteristic fixed position with respect to the light in as protected a place as possible.

These experiments show that sunlight modifies the normal physiological changes taking place in protoplasm, checking some of the processes and probably accelerating others. It appears that the acid and alkaline relations are affected probably through a disturbance in the relations of the hydrogen and the hydroxyl ions. The starfish with one half of its upper surface in the light and one half in the shade moves from the light into the shade because of this interference with its normal physiological activities.

These experiments were performed in the Biological Laboratory of the Brooklyn Institute of Arts and Sciences, Cold Spring Harbor, Long Island, July and August, and I am under obligations to Dr. C. B. Davenport, the director of the laboratory, for the privileges and opportunities so kindly extended.

Hansford MacCurdy

Alma College,
October 3, 1912